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AN

ELEMENTARY INTRODUCTION

TO

MINERALOGY.

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AN
ELEMENTARY INTRODUCTION
TO
MINERALOGY,

BY THE LATE

WILLIAM PHILLIPS.

New Edition,

WITH EXTENSIVE ALTERATIONS AND ADDITIONS,

BY

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PREFACE.

When it was proposed to the Editors to undertake the preparation of a new edition of the elementary treatise on Mineralogy by the late W. Phillips, their first impression was to revise with care the third edition of the work, and to make such additions to it as later discoveries might render necessary. But after an attentive perusal of only a small portion of the volume, they found, that if the form of the third edition was to be retained, the corrections, alterations and additions would be so numerous as to render the labour of revision greater than would be occasioned by the entire recomposition of the whole treatise. Being aware also of the great advance since 1823 in the knowledge of the physical properties of minerals, as well as of their chemical constitutions; and recollecting the important generalizations introduced into mineralogy since that time, it appeared to the Editors that the work must both in form and substance be new. It has accordingly been entirely reconstructed, and the latest observations and discoveries, as far as the Editors are aware, have been introduced.

The peculiar character of the third edition of the work of W. Phillips, and which rendered it so generally acceptable to all who were engaged in mineralogical pursuits was, its copious illustrations of crystalline forms, and the extensive lists of measured angles, which lists have been greatly extended in this edition. The methods of representing crystals in this volume differ from those employed by the late W. Phillips; but the Editors trust that by ordinary attention on the part of the reader, they will not occasion any embarrassment when he compares them with the figures given by that author.

In preparing this Work, the Editors have availed themselves of the opportunities afforded by specimens from different collections, of remeasuring a great number of the crystals described; they have thus been enabled to correct several errors of form, and, having deduced the angles by calculation from the best observations, they believe that the forms and angles inserted in this work are as nearly accurate as they can at present be rendered.

In the compilation of this volume, the Editors have relied chiefly on Zippe's edition of Mohs, and on Hausmann; but they have also availed themselves of such other sources of information as appeared best calculated to increase the accuracy of the descriptions. The analyses are almost entirely selected from Rammelsberg's "Handwörterbuch des chemischen Theils der Mineralogie," and the four Supplements to that work. In making the selection, the Editors have been guided by his criticisms, and have endeavoured to avoid encumbering the book, and misleading the reader by the insertion of analyses palpably inaccurate. They are also indebted to Professor Rammelsberg for an early communication of the results of his elaborate chemical examination of tourmaline subsequent to the appearance of the fourth supplement.

It has been the practice in other mineralogical treatises to omit all the optical characters of minerals except those of colour and lustre; but it has appeared to the Editors that some account of the characters and phenomena which depend upon refraction and polarization would confer a higher interest on the study of minerals, and they have accordingly inserted many notices of these curious properties. The geometrical expressions for computing the symbols of crystals, and the angles the faces make with each other, are more numerous than is usual in elementary treatises, and they will probably meet every case likely to occur. The shape in which they are presented has been chosen with the view of shortening, as far as possible, the arithmetical operations they involve in their application.

I think it due to Professor Miller to state, that nearly the whole of the assistance which I have been able to render to the composition of this volume consists in such information relating to many of the minerals described as a long acquaintance with them has enabled me to afford, and in having supplied such specimens and crystals as it appeared desirable again to examine and measure. In every other respect the treatise has been composed and arranged entirely by Professor Miller.

H. J. B.

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Page 19	fig.	28	at apex, *for* 100 *read* 001.
31	line	2	for *hkk* read *hkl*.
74	—	17	*for* resinous *read* vitreous.
76	—	16	*for* 170·42 *read* 340·84.
110	—	2	from below, *for* 40° 0′ *read* 42° 0′.
138	—	13	*for* 1·8 *read* 1·5.
147	—	27	*for* 54° 16′ *read* 54° 44′.
148	—	15	for *c* 011 read *c* 001.
163	—	13	*for* 19° 16′ *read* 19° 6′.
174	—	15	*for* Riddrhytta *read* Kiddarhytta.
181	—	27	*for* Condurra *read* Condurrow.
217	—	9	*after* 'adamantine' *insert* 'Hyacinth-red. Streak the same.'
227	—	7	dele *uc* 69 52.
230	—	17	*for* Wallis *read* the Valais.
236	fig.	252	between *e* and *c*, for *r* read γ.
	—	—	between e'' and p'' for s' read s''.
242	bottom line,		for *qo* read *go*.
245	line	9	from below, *after* '$01\bar{1}$' *insert* '*b* $2\bar{1}\bar{1}$.'
246	—	14	for *rb* read λb.
	—	16	for γb read *rb*.
252	—	11	*for* hyrophane *read* hydrophane.
272	—	19	for *ea* read *la*.
274	—	3	dele *cb* 90 0.
	—	6	dele *ca* 90 0.
282	—	3	*for* $\bar{1}10$ *read* $\bar{1}11$, and *for* 80° 30′ *read* 80° 33′.
288	fig.	310	transpose g, u, v, and g', u', v'.
312	—	325	transpose δ, ζ, η, and δ', ζ', η'.
327	line	27,	*for* 010 *read* 101.
336	—	2	and 3 from below, for *z* read $r_{,}$.
382	—	15	for r' read *r*.
	—	20	for e' read *e*.
405	—	9	from below, *for* cove *read* clove.
485	—	25,	*for* 041 *read* $04\bar{1}$.
	—	26,	*for* 232 *read* $23\bar{2}$.
526	—	11,	*for* So *read* Is.
528	fig.	520,	between *z* and *o*, for *q* read *y*.
535	line	4	from below, *for* sufatée *read* sulfatée.
537	—	3	for v' read *v*.
565	fig.	563,	between *a* and *m* insert *r*.

AN
ELEMENTARY INTRODUCTION
TO
MINERALOGY.

INTRODUCTION.

1. The surface or crust of the earth, as the very thin stratum with which we are acquainted has been named, consists of vast plains and rocky or mountain masses, the nature, causes, and relations of which are the objects of Geological inquiry.

If we examine the mountain masses, we shall find, that different portions of the same rock will present great differences both of physical characters and chemical composition. But we may also discover in different rocks some substances which occur, either as the linings of cavities, or filling veins, or otherwise disseminated through them, and which, wherever found, present respectively nearly the same forms and physical characters, and are generally composed of nearly the same chemical constituents.

These are termed minerals, and are divided into kinds or species, the descriptions of which, and the methods of distinguishing them from each other, are the objects of the following treatise.

The methods here employed are, however, occasionally defective in consequence of differences in the physical characters of some minerals which nearly agree in their chemical constitution, and of differences in the chemical composition of others, the forms and other properties of which are nearly alike.

Indeed, at the very outset of our work, the inquiry, What is a mineral species? is encumbered with considerable difficulty; involving as it does the chemical doctrine of isomorphous substitution, and being unprovided with any rule by which the essential elements of a mineral may be distinguished from the foreign matter with which it is almost universally mixed.

Spinelle affords an instance of the uncertainty which follows a strict chemical discrimination of kinds among a considerable number of apparently similar minerals; and we do not perceive any clear rule for deciding whether the individuals which form such apparently natural groups should be kept together as varieties of the same mineral as we have arranged them, or be regarded chemically as distinct species, and be denoted by the different names assigned to them by other authors.

2. Another embarrassment arises from the introduction of several substances among minerals which do not appear to belong to mineralogy.

No part, for example, of the tribe of combustibles of vegetable origin ought, we think, to be classed among minerals.

Modern turf certainly cannot claim a place among them; and passing from this through the wood coal of Bovey and other places, to the fossil beds of ancient forests, the whole appears to belong to the series of organic remains which constitute so important a branch of geological investigation. Yet, in conformity with the practice of other authors, we have retained this series in our system.

Some other substances introduced into works on mineralogy are also retained in this treatise, although more properly belonging to geology. We allude to some of the slates and clays, and to some of the hydrous silicates of alumina of variable character and composition.

3. Of the minerals described in this work, there are many which we have not seen, and the descriptions of which are consequently given on the authority of other observers.

Of several of these, we have repeatedly endeavoured, but in vain, to obtain specimens, having been desirous of adding something to the very bare descriptions of some of them; and of assisting in supporting, or otherwise, the claims of others to be regarded as separate species: for it appears to us very uncertain whether some of the supposed new substances are really other than accidental mixtures of the elements of other minerals, or, impure varieties, containing uncertain and variable proportions of different kinds of foreign matter.

It is also probable that some of the apparent differences in the chemical constitution of particular minerals may have been occasioned by the analysis of misnamed specimens, instead of the substances purported to be examined.

4. There are a few substances which have been more or less perfectly described in former works on the sole authority of the discoverers of them, but of which there are not any specimens, as far as we have been able to ascertain, existing in any known collection. Of this class desmine affords an example. With respect to these, as it is not desirable to retain any uncertain kinds, or to exclude any really distinct minerals, we shall give them as they were originally described, and leave it to the judgment of future observers to retain them or to reject them from future systems.

DESCRIPTIVE CHARACTERS.

5. The several principal characters employed in describing minerals may be classed under the following heads. They will be separately considered, and the subordinate characters given in the immediately ensuing sections.

Form.
Cleavage.
Structure.
Fracture.
Transparency.
Lustre.
Refraction.
Colour.
Streak.
Sectility.
Malleability.
Flexibility.
Touch.
Hardness.
Specific gravity.
Magnetism.
Electricity.
Phosphorescence.
Smell.
Taste.
Effects of heat in glass tubes.
Effects of heat before the blowpipe.
Effects of liquid reagents.
Chemical composition.

FORM.

6. The forms under which minerals occur are either determinate, being those of geometric solids, named crystals, which are generally proper to the mineral substances of which they respectively consist, or they are indeterminate, being irregular and accidental shapes, some of which have been termed imitative, and all of which may be common to many different kinds of minerals.

7. In the following treatise the mutual inclination of any two of the planes which bound a solid, will be expressed by the angle between straight lines drawn from a point within the solid, respectively perpendicular to the two planes. The angle between perpendiculars to the planes, or normals as they will generally be called, is the supplement of the angle between the planes according to the usual mode of expressing it. If the

angles between planes, as given in previous works, are severally subtracted from 180°, the differences will be the angles between normals to such faces, and they may thus be compared with the angles quoted in this volume.

The advantage of this change will be importantly felt by the observer at every step in his examination of crystals, on account of the great facility it affords in computing the angles between their planes, and in comparing them with the results of measurement.

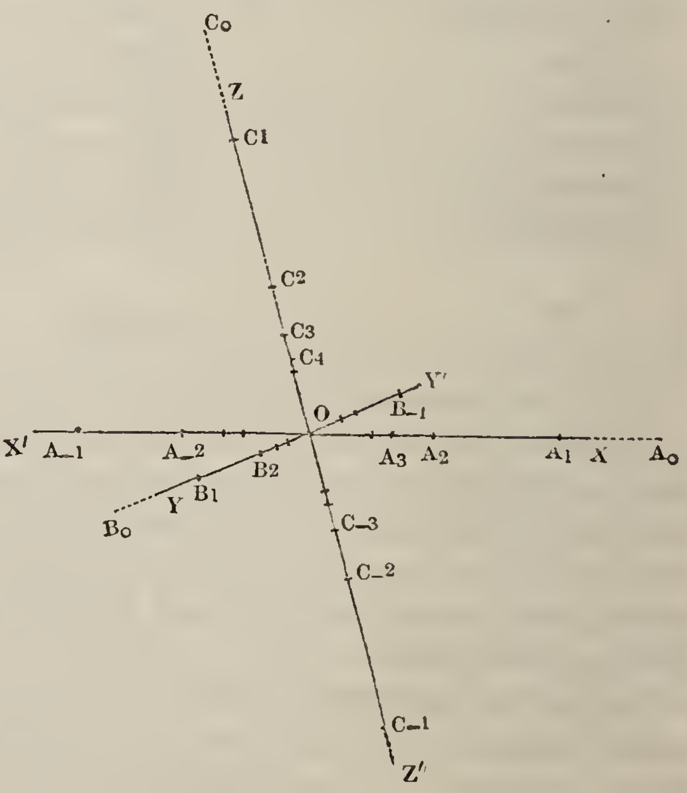
GENERAL GEOMETRICAL PROPERTIES OF CRYSTALS.

8. Many natural substances occur in the form of solids bounded by plane surfaces. These, when broken, frequently exhibit a tendency to separate in the directions of planes, passing through any point within them, either parallel to some of the bounding planes, or else making given angles with them. Solids of this description are called 'crystals;' the planes by which they are bounded their 'faces,' and the planes in which they have a tendency to separate their 'cleavage planes.'

9. The mutual inclinations of the faces and cleavage planes of a crystal are subject to a law which may be enunciated as follows:—

Through any point O within the crystal, let planes be drawn parallel to each of its faces and cleavage planes. Let OX, OY, OZ be any three intersections of these planes, not all in one plane; and let any face, or cleavage plane, meet OX, OY, OZ in A_1, B_1, C_1. In OX take $OA_2 = \frac{1}{2}OA_1$, $OA_3 = \frac{1}{3}OA_1, \ldots$ towards X; $OA_{-1} = OA_1$, $OA_{-2} = OA_2$, $OA_{-3}, = OA_3, \ldots$ in the opposite direction, and $OA_1 = \frac{1}{0}OA_1 =$ infinity, in either direction. And let the points B_{-1}, B_2, B_{-2}, B_3, $B_{-3}, \ldots, B_0$, C_{-1}, C^2, C_{-2}, C_3, $C_{-3}, \ldots, C_0$, be determined in the same manner from OB_1, OC_1, respectively. Then, any face, or cleavage plane, of the crystal will be parallel to a plane drawn through three

FIG. 1.



points thus determined, one being in each of the three lines XOX', YOY', ZOZ'.

10. The lines XOX', YOY', ZOZ' will be called 'axes;' the portions OA_1, OB_1, OC_1 'parameters.'

The symbol 321 will be used to denote the face parallel to $A_3B_2C_1$, $2\bar{1}4$ the face parallel to $A_2B_{-1}C_4$, and generally, hkl will be used to denote the face parallel to $A_hB_kC_l$, where

$$OA_h = \tfrac{1}{h}OA_1,\ OB_k = \tfrac{1}{k}OB_1,\ OC_l = \tfrac{1}{l}OC_1,$$

h, k, l being any positive or negative whole numbers including zero, and OA_h, OB_k, OC_l measured towards X, Y, Z, or towards X′, Y′, Z′, according as h, k, l are positive or negative.

The numbers 3, 2, 1, and 2, $\bar{1}$, 4 in the two former examples, and the letters h, k, l in the latter, will be called 'indices.' An index taken negatively will be distinguished by a negative sign placed over it.

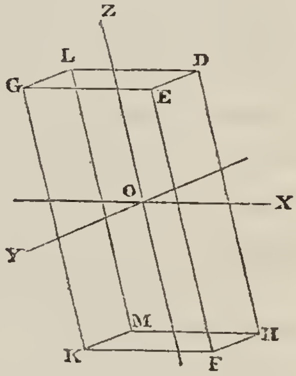
The indices h, k, l, which by taking different integral values determine the positions of the different faces of the same crystal, are seldom large. The highest index does not commonly exceed six.

11. Parallel and opposite faces have the same indices with different signs.

12. The linear dimensions of the faces are not subject to any law; consequently, a face of a crystal may be represented by any plane parallel to it, on the same side of the point O.

13. When one of the indices of a face is zero, the point in which the face intersects the corresponding axis is indefinitely distant, or the face is parallel to that axis. When two of the indices are zero, the face is parallel to the two corresponding axes.

FIG. 2.



In the parallelopiped DFG (fig. 2) having its edges parallel to the axes OX, OY, OZ, DEF, LGK are the faces 100, $\bar{1}00$; GEF, LDH are the faces 010, $0\bar{1}0$, and DEG, HFK, are the faces 001, $00\bar{1}$.

14. In OX, OY, OZ (figs. 3, 4, 5, 6,) take OH, OK, OL, respectively proportional to $\frac{1}{h}OA_1$, $\frac{1}{k}OB_1$, $\frac{1}{l}OC_1$; $O\bar{H} = OH$, $O\bar{K} = OK$, $O\bar{L} = OL$.

Then, in the prism QR (fig. 3) having $KL\bar{K}\bar{L}$ for its section, and its axis parallel to OX, QKL, $R\bar{K}\bar{L}$ are the faces $0kl$, $0\bar{k}\bar{l}$, and $QK\bar{L}$, $R\bar{K}L$ are the faces $0k\bar{l}$, $0\bar{k}l$.

In the prism having $LH\bar{L}\bar{H}$ (fig. 4) for its section, and its axis parallel to OY, HSL, $\bar{H}T\bar{L}$, are the faces $h0l$, $\bar{h}0\bar{l}$, and $HS\bar{L}$, $\bar{H}TL$ are the faces $h0\bar{l}$, $\bar{h}0l$.

FIG. 3.

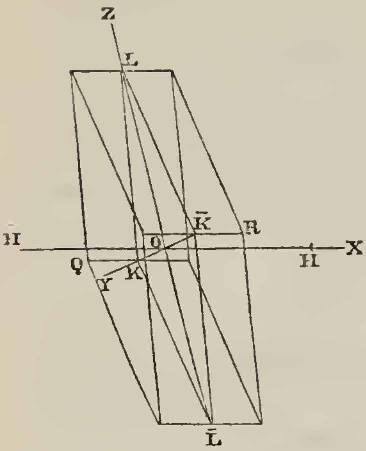


FIG. 4.

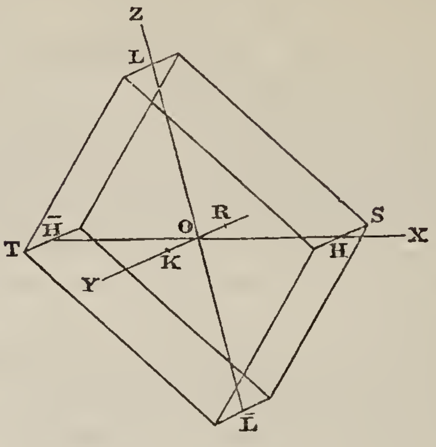


FIG. 5.

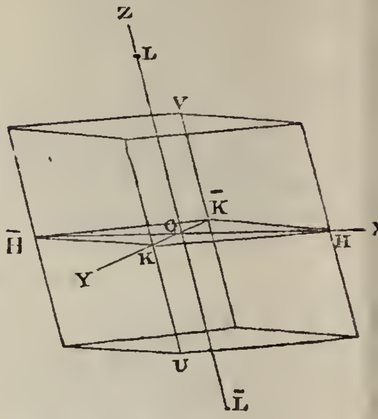
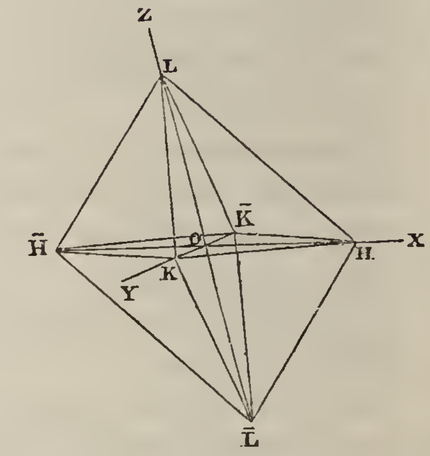


FIG. 6.



In the prism UV (fig. 5), having $\mathrm{HK\bar{H}\bar{K}}$ for its section, and its axis parallel to OZ, HKU, $\mathrm{\bar{H}\bar{K}V}$ are the faces $hk0$, $\bar{h}\bar{k}0$, and $\mathrm{\bar{H}KU}$, $\mathrm{H\bar{K}V}$ are the faces $\bar{h}k0$, $h\bar{k}0$.

In the double pyramid $\mathrm{L\bar{L}}$ (fig. 6), bounded by planes through H, K, L, &c., HKL, $\mathrm{\bar{H}\bar{K}\bar{L}}$ are the faces hkl, $\bar{h}\bar{k}\bar{l}$; $\mathrm{\bar{H}KL}$, $\mathrm{H\bar{K}\bar{L}}$ are the faces $\bar{h}kl$, $h\bar{k}\bar{l}$; $\mathrm{H\bar{K}L}$, $\mathrm{\bar{H}K\bar{L}}$ are the faces $h\bar{k}l$, $\bar{h}k\bar{l}$; $\mathrm{HK\bar{L}}$, $\mathrm{\bar{H}\bar{K}L}$ are the faces $hk\bar{l}$, $\bar{h}\bar{k}l$.

15. The face hkl may be denoted by any three integers proportional to the indices h, k, l respectively.

16. The mutual inclinations of the axes and the ratios of the parameters are the same, at a given temperature, for all crystals of the same species. The symbols of the faces may be different. Hence, the angles YOZ, ZOX, XOY, which the axes make with each other, and the ratios of two of the parameters OA_1, OB_1, OC_1, to the third, are five elements by which each crystalline species is characterized.

17. The law enunciated in (9) may be expressed in a shape more convenient for calculation in the following manner:—

Let the axes OX, OY, OZ meet the surface of a sphere described round O as a centre, in the points X, Y, Z. Let the radius OP, drawn perpendicular to the face hkl, meet the surface of the sphere in P, and let $\mathrm{OA}_1 = a$, $\mathrm{OB}_1 = b$, $\mathrm{OC}_1 = c$. Then

$$\frac{a}{h}\cos \mathrm{PX} = \frac{b}{k}\cos \mathrm{PY} = \frac{c}{l}\cos \mathrm{PZ}.$$

The sphere to the surface of which the faces of a crystal are referred will be called the 'sphere of projection.' The extremity of a radius of the sphere drawn perpendicular to any face will be called the 'pole' of that face. A face and its pole will be denoted by the same symbol.

18. It frequently happens that a number of faces of a crystal intersect each other, or would intersect if produced till they met, in parallel lines. Such an assemblage of faces is called a 'zone.' The faces of a zone are all perpendicular to one plane, and their poles lie in a great circle, which will be called the 'zone-circle.' A line parallel to the intersections of the faces of a zone will be called the 'axis' of the zone.

19. Let hkl, pqr be the symbols of any two faces in a zone. Then, if

$$\mathrm{u} = kr - lq,\quad \mathrm{v} = lp - hr,\quad \mathrm{w} = hq - kp,$$

uvw will be the symbol of the zone containing the faces hkl, pqr, or of the zone-circle through the poles of hkl, pqr.

20. A face may be common to two zones, or its pole may be the intersection of two zone-circles.

Let hkl, pqr be the symbols of two zones. Then, if

$$u = \mathrm{kr} - \mathrm{lq},\quad v = \mathrm{lp} - \mathrm{hr},\quad w = \mathrm{hq} - \mathrm{kp},$$

uvw will be the symbol of the face common to the zones hkl, pqr.

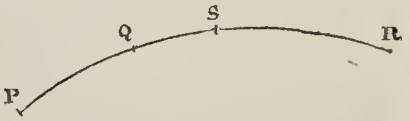
21. Let uvw be the symbol of a face in the zone uvw. Then,

$$\mathrm{u}u + \mathrm{v}v + \mathrm{w}w = 0.$$

Any positive or negative whole numbers, including zero, which, when substituted for u, v, w, satisfy the above equation, are the indices of a face in the zone uvw; and any positive or negative whole numbers, including zero, which, when substituted for u, v, w, satisfy the same equation, are the indices of a zone containing the face uvw.

22. Let P, Q, R, S be four poles in one zone-circle, PR being larger than PQ, and PQ, PR, PS measured in the same direction from P. Let their symbols be,—

FIG. 7.



P efg, Q hkl, R pqr, S uvw.

$$\frac{[\mathrm{PS}]}{[\mathrm{SR}]} = \frac{fw - gv}{vr - wq} = \frac{gu - ew}{wp - ur} = \frac{ev - fu}{uq - vp},$$

$$\frac{[\mathrm{PQ}]}{[\mathrm{QR}]} = \frac{fl - gk}{kr - lq} = \frac{gh - el}{lp - hr} = \frac{ek - fh}{hq - kp}.$$

Then,

$$\frac{[\mathrm{PS}]}{[\mathrm{SR}]}(\cot \mathrm{PS} - \cot \mathrm{PR}) = \frac{[\mathrm{PQ}]}{[\mathrm{QR}]}(\cot \mathrm{PQ} - \cot \mathrm{PR}).$$

By means of this equation, having given PQ, PR, and the symbols of P, Q, R, S, we can find PS; or, having given PQ, PR, PS, the indices u, v, w may be found, by combining it with the equation $\mathrm{u}u + \mathrm{v}v + \mathrm{w}w = 0$, in which uvw is the symbol of the zone-circle PQR.

23. If $\frac{m}{n} = \frac{[\mathrm{QR}]}{[\mathrm{PQ}]}\frac{\sin \mathrm{PQ}}{\sin \mathrm{QR}}\frac{\sin(\mathrm{PR}-\mathrm{PS})}{\sin \mathrm{PS}}$, m, n being integers,

$$u = me + np, \quad v = mf + nq, \quad w = mg + nr.$$

Whence, having given PQ, PR, PS, and the symbols of P, Q, R, the symbol of S may be found.

24. Let $\tan\theta = \frac{[\mathrm{SR}]}{[\mathrm{PS}]}\frac{[\mathrm{PQ}]}{[\mathrm{QR}]}\frac{\sin \mathrm{QR}}{\sin \mathrm{PQ}}$. Then,

$$\tan(\mathrm{PS} - \tfrac{1}{2}\mathrm{PR}) = \tan\tfrac{1}{2}\mathrm{PR}\,\tan(45^\circ - \theta).$$

Whence, having given PQ, PR, and the symbols of P, Q, R, S, PS may be found.

25. Let Q, S lie between P and R; $i = \frac{[\mathrm{PS}][\mathrm{QR}]}{[\mathrm{SR}][\mathrm{PQ}]}$. Then,

$$\cos(2\mathrm{PR} - \mathrm{PQ} - \mathrm{RS}) = (1-i)\cos(\mathrm{PQ} - \mathrm{RS}) + i\cos(\mathrm{PQ} + \mathrm{RS}).$$

Whence, having given PQ, RS, and the symbols of P, Q, R, S, PR may be found.

26. To change the axes of a crystal.

Let the new axes be parallel to the axes of the zones efg, hkl, pqr. Let uvw be the symbol of any face referred to the old axes, $u'v'w'$ its symbol when referred to the new axes. Then

$$u' = \mathrm{e}u + \mathrm{f}v + \mathrm{g}w,$$
$$v' = \mathrm{h}u + \mathrm{k}v + \mathrm{l}w,$$
$$w' = \mathrm{p}u + \mathrm{q}v + \mathrm{r}w.$$

27. To change the parameters of a crystal.

Let hkl be the symbol of a given face with the old parameters, $h'k'l'$ its symbol with the new parameters, uvw the symbol of any other face with the old parameters, $u'v'w'$ its symbol with the new parameters. Then

$$u' = h'klu, \quad v' = hk'lv, \quad w' = hkl'w.$$

28. In many crystals axes may be discovered which make right angles with each other; in others, axes of which one is perpendicular to the other two; and in others, axes making equal angles with each other. In the crystals with equiangular axes, and in some of the crystals with rectangular axes, equal

parameters may be found; and, among the remaining crystals with rectangular axes, some which have two of the parameters equal. Upon the differences in the positions of the axes with respect to each other, and in the relation between the parameters, above enumerated, is founded the arrangement of crystals in systems.

1. In the cubic system the axes are rectangular and the parameters equal.

2. In the pyramidal system the axes are rectangular and two of the parameters equal. In this system we shall always suppose a and b equal.

3. In the rhombohedral system the axes make equal angles with each other, and the parameters are equal.

4. In the prismatic system the axes are rectangular.

5. In the oblique system one axis is perpendicular to each of the other two. We shall always suppose the axis OY perpendicular to each of the axes OZ and OX.

6. The anorthic system includes all crystals which cannot be referred to any of the preceding systems.

29. The different systems of crystallization are further distinguished by the various kinds of symmetry observable in the distribution of the faces of the crystals belonging to them. For, if a face occur having the symbol hkl, it will generally be accompanied by the faces having for their symbols certain arrangements of $\pm h$, $\pm k$, $\pm l$, determined by laws peculiar to each system, and which will be fully explained when we come to describe each system separately.

30. A 'form' in crystallography is the figure bounded by a given face and the faces which, by the laws of symmetry of the system of crystallization, are required to coexist with it. A form will be denoted by the symbol of any one of its faces.

The 'holohedral forms' of any system are those which possess the highest degree of symmetry of which the system admits. 'Hemihedral forms' are those which may be derived from a holohedral form by supposing half of the faces of the latter omitted according to a certain law.

The figure bounded by the faces of any number of forms is called a 'combination' of those forms.

31. The elements of a crystal are the inclinations of the axes YOZ, ZOX, XOY, and the ratios of two of the parameters a, b, c, to the third. In the cubic system, where the axes are rectangular and parameters equal, all the elements are determined. In the pyramidal system, where the axes are rectangular and two of the parameters are equal, the ratio of either of them to the third is the only variable element. In the rhombohedral system, where the axes make equal angles with each other and the parameters are equal, the angle between any two of the axes is the

only variable element. In the prismatic system, where the axes are rectangular, the ratios of two of the parameters to the third, are two variable elements. In the oblique system, where one of the axes is at right angles to the other two, the inclination of the two axes which are perpendicular to the third, and the ratios of two of the parameters to the third, are three variable elements. In the anorthic system, the angles between the axes and the ratios of two of the parameters to the third, are all variable.

In practice it is found more convenient to substitute, for the elements enumerated above, certain angles from which the angles of the crystal can be readily computed. The angular elements appropriate to each system will be given in the section devoted to that system.

The geometrical description of a crystal is complete when we have given the angular elements, the symbols of the simple forms of which it is a combination, and the symbols of its cleavage forms.

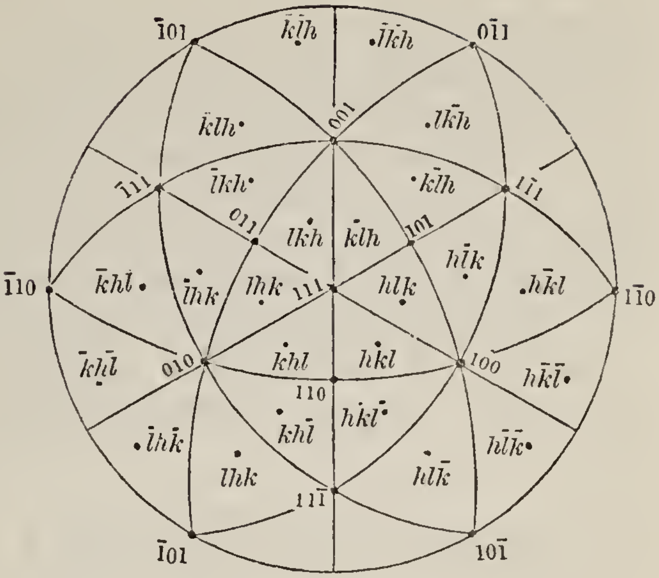
CUBIC SYSTEM.

32. In the cubic system the crystallographic axes are at right angles to each other, and the parameters are all equal.

33. The form hkl is bounded by all the faces having for their symbols the different arrangements of $\pm h$, $\pm k$, $\pm l$, taken three at a time. When h, k, l are all different, they afford the forty-eight arrangements contained in the annexed table. When the values of any two of the indices are equal, or when one of them is zero, the number of arrangements will reduce itself to twenty-four. When two of the indices are equal, and the third is zero, the number will be twelve. When the three indices are equal, it will be eight, and when two indices are zero, it will be six.

$h\ k\ l$	$k\ l\ h$	$l\ h\ k$	$l\ k\ h$	$k\ h\ l$	$h\ l\ k$
$h\ \bar{k}\ \bar{l}$	$k\ \bar{l}\ \bar{h}$	$l\ \bar{h}\ \bar{k}$	$l\ \bar{k}\ \bar{h}$	$k\ \bar{h}\ \bar{l}$	$h\ \bar{l}\ \bar{k}$
$\bar{h}\ k\ \bar{l}$	$\bar{k}\ l\ \bar{h}$	$\bar{l}\ h\ \bar{k}$	$\bar{l}\ k\ \bar{h}$	$\bar{k}\ h\ \bar{l}$	$\bar{h}\ l\ \bar{k}$
$\bar{h}\ \bar{k}\ l$	$\bar{k}\ \bar{l}\ h$	$\bar{l}\ \bar{h}\ k$	$\bar{l}\ \bar{k}\ h$	$\bar{k}\ \bar{h}\ l$	$\bar{h}\ \bar{l}\ k$
$\bar{h}\ \bar{k}\ \bar{l}$	$\bar{k}\ \bar{l}\ \bar{h}$	$\bar{l}\ \bar{h}\ \bar{k}$	$\bar{l}\ \bar{k}\ \bar{h}$	$\bar{k}\ \bar{h}\ \bar{l}$	$\bar{h}\ \bar{l}\ \bar{k}$
$\bar{h}\ k\ l$	$\bar{k}\ l\ h$	$\bar{l}\ h\ k$	$\bar{l}\ k\ h$	$\bar{k}\ h\ l$	$\bar{h}\ l\ k$
$h\ \bar{k}\ l$	$k\ \bar{l}\ h$	$l\ \bar{h}\ k$	$l\ \bar{k}\ h$	$k\ \bar{h}\ l$	$h\ \bar{l}\ k$
$h\ k\ \bar{l}$	$k\ l\ \bar{h}$	$l\ h\ \bar{k}$	$l\ k\ \bar{h}$	$k\ h\ \bar{l}$	$h\ l\ \bar{k}$

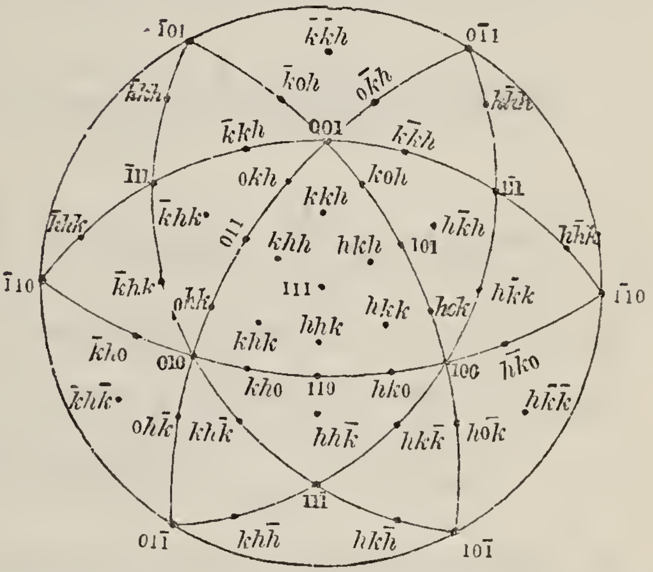
FIG. 8.



34. If we suppose h to be the greatest, and l the least of the three unequal indices hkl, fig. 8, will represent the distribution of the poles of the form hkl, on the surface of the sphere of projection.

Fig. 9 exhibits the poles of the forms obtained by making one of the indices zero, or by making two of them equal. Both figures show the poles of the forms 100, 111, and 101.

FIG. 9.



35. The form bounded either by all the faces of the form hkl, which have an odd number of postive indices, or by all the faces which have an odd number of negative indices, is said to be hemihedral with inclined faces, and will be denoted by the symbol κhkl, where hkl is the symbol of any one of its faces. The upper and lower halves of the table in (33) contain the symbols of the faces of κhkl, $\kappa\bar{h}\bar{k}\bar{l}$ respectively.

If the surface of the sphere of projection be divided into eight triangles by zone-circles through every two of the poles of the form 100, the poles of κhkl will be found in four alternate triangles, and those of $\kappa\bar{h}\bar{k}\bar{l}$ in the remaining four alternate triangles.

36. The form bounded either by all the faces of the form hkl, the indices of which stand in the order $hklhk$, or by all the faces the indices of which stand in the order $lkhlk$, is said to be hemihedral with parallel faces, and will be denoted by the symbol πhkl, where hkl is the symbol of any one of its faces. The right and left halves of the table in (33) contain the symbols of the faces of πhkl, πlkh respectively.

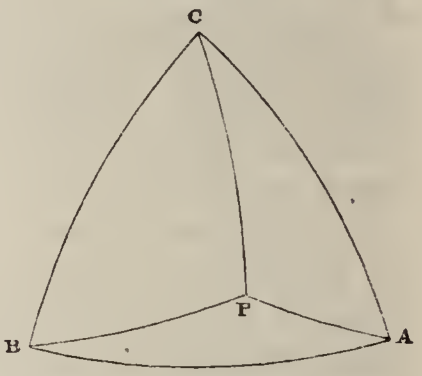
If the surface of the sphere of projection be divided into twenty-four triangles by zone-circles passing through every two of the poles of the form 111, the poles of πhkl will be found in twelve alternate triangles, and the poles of πlkh in the remaining twelve alternate triangles.

37. Any number of holohedral forms may occur in combination with each other, and with any hemihedral forms with inclined faces, or with any hemihedral forms with parallel faces. Hemihedral forms with inclined faces have never been observed in combination with hemihedral forms with parallel faces.

38. To find the position of the pole of any face.

Let A, B, C be the poles of 100, 010, 001, and let P be the pole of hkl. BC, CA, AB are quadrants.

FIG. 10.



$$\cos \mathrm{PA} = \frac{h}{\sqrt{(h^2 + k^2 + l^2)}},$$

$$\cos \mathrm{PB} = \frac{k}{\sqrt{(h^2 + k^2 + l^2)}},$$

$$\cos \mathrm{PC} = \frac{l}{\sqrt{(h^2 + k^2 + l^2)}}.$$

$$\tan \mathrm{PAB} = \frac{l}{k}, \quad \tan \mathrm{PBC} = \frac{h}{l}, \quad \tan \mathrm{PCA} = \frac{k}{h}.$$

39. To find the distance between the poles of any two faces.

Let P be the pole of hkl, Q the pole of pqr. Then

$$\cos \mathrm{PQ} = \frac{hp + kq + lr}{\sqrt{(h^2 + k^2 + l^2)}\sqrt{(p^2 + q^2 + r^2)}}.$$

40. The poles of the form hkl are symmetrically arranged with respect to zone-circles through every two of the poles of the form 100, and through every two of the poles of the form 111. The poles of κhkl are symmetrically arranged with respect to the zone-circles through every two of the poles of the form 111; and the poles of πhkl are symmetrically arranged with respect to zone-circles through every two of the poles of the form 100.

41. Two hemihedral forms, either with inclined or parallel faces, derived from the same holohedral form, are identical in all respects, position excepted; for, by turning the sphere of projection through two right angles, round any two opposite poles of the form 100, the poles of κhkl come into the places of the poles of $\kappa \bar{h}\bar{k}\bar{l}$, and the poles of πhkl come into the places of the poles of πlkh. But a combination of κhkl and κpqr is essentially different from a combination of κhkl and $\kappa \bar{p}\bar{q}\bar{r}$; and a combina-

tion of πhkl and πpqr is essentially different from a combination of πhkl and πrqp.

42. If the distance between the poles of any two faces of either of the forms $hk0$, hkk, be given, and we express the cosine of the given distance in terms of the indices of the faces, we obtain an equation from which the indices may be found.

If the distances between the pole of any face of the form hkl, and the poles of each of two other faces of the same form, be given, and we express the cosines of the given distances in terms of the indices of the faces, we obtain two equations from which the indices may be found.

43. In the following description of the different simple forms of the cubic system, the letter placed upon the edge in which any two faces intersect, will be used to denote the angle between normals to the two faces. The edges at which equal angles are made by the intersecting faces are denoted by the same letter. The arrangement of the poles is shown in figs. 8, 9, 28. The number of faces is given in (33).

44. The form 100 (fig. 11) has six faces, and is called a cube, its faces being parallel to those of the cube of geometry.

$$\mathrm{F} = 90^\circ.$$

45. The form 111 (fig. 12) has eight faces, and is called an octahedron, its faces being parallel to those of a regular octahedron.

$$\mathrm{D} = 70^\circ\ 31'\cdot 7.$$

46. The form $\kappa 111$ (fig. 13) is a regular tetrahedron.

$$\mathrm{T} = 109^\circ\ 28'\cdot 3.$$

FIG. 11.

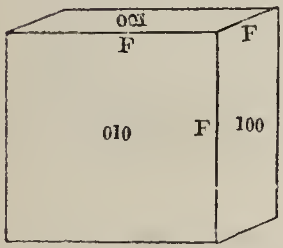


FIG. 12.

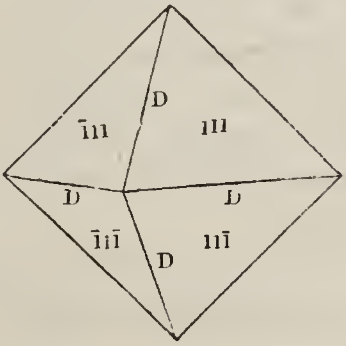
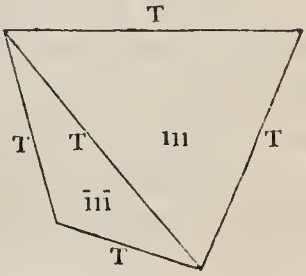


FIG. 13.



47. In a combination of the forms 100 and 111 (fig. 14), the faces of one form truncate the solid angles of the other.

A normal to any face o, of the form 111, makes an angle of 54° 44′ with a normal to any adjacent face a of the form 100.

In a combination of the forms 100 and $\kappa 111$ (fig. 15), the faces of 100 truncate the edges of $\kappa 111$.

FIG. 14.

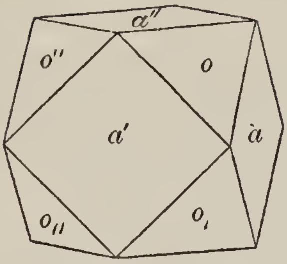


FIG. 15.

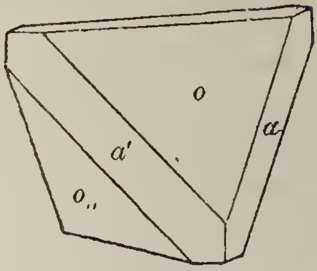
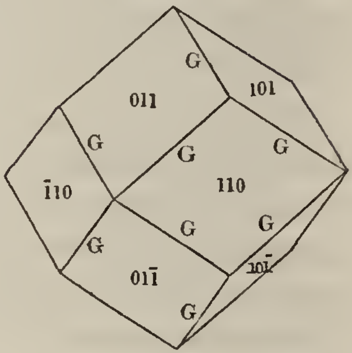


FIG. 16.



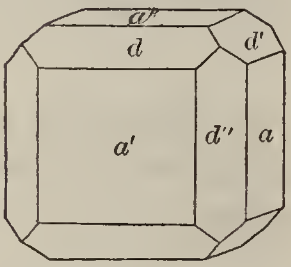
48. The form 101 (fig. 16) has twelve faces, and is called a dodecahedron.

$$G = 60^\circ.$$

Any two alternate faces, meeting at their acute angles, make with each other an angle of 90°.

49. In a combination of the forms 100 and 101 (fig. 17), the faces of 101 truncate the edges of 100.

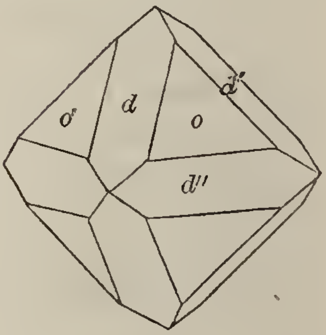
FIG. 17.



A normal to any face *d* of the form 101 makes an angle of 45° with normals to each of the adjacent faces *a* of the form 100, an angle of 135° with normals to each of the opposite faces, and an angle of 90° with normals to each of the two remaining faces.

In a combination of the forms 111 and 101 (fig. 18), the faces of 101 truncate the edges of 111.

FIG. 18.



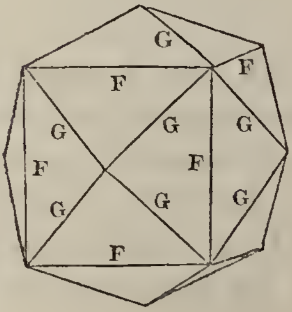
A normal to any face *d* of the form 101 makes an angle of 35° 16′ with normals to each of the adjacent faces *o* of the form 111; an angle of 144° 44′ with normals to each of the opposite faces, and an angle of 90° with normals to each of the four remaining faces.

50. The form *hk*0 (fig. 19) has twenty-four faces.

$$\cos F = \frac{2hk}{h^2 + k^2},$$

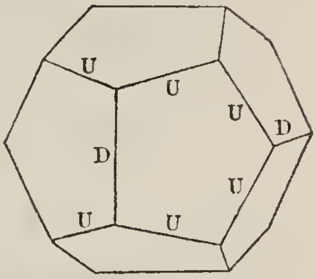
$$\cos G = \frac{h^2}{h^2 + k^2}.$$

FIG. 19.



In the form 210, F = 36° 52′, G = 36° 52′.
In the form 310, F = 53° 8′, G = 25° 51′.
In the form 320, F = 22° 37′, G = 46° 11′.
In the form 520, F = 46° 24′, G = 30° 27′.

FIG. 20.



51. In the form $\pi 0kh$, h being greater than k (fig. 20),

$$\cos \text{D} = \frac{h^2 - k^2}{h^2 + k^2},$$

$$\cos \text{U} = \frac{hk}{h^2 + k^2}.$$

In the form π012, D = 53° 8′, U = 66° 25′.
In the form π023, D = 67° 22′, U = 62° 31′.
In the form π034, D = 73° 44′, U = 61° 19′.

52. In a combination of the forms 100, $hk0$, the faces of 100 truncate the solid angles of $hk0$, in which the edges G meet.

210,100 = 26° 34′, 210,010 = 63° 26′, 210,001 = 90° 0′.
310,100 = 18° 26′, 310,010 = 71° 34′, 310,001 = 90° 0′.
320,100 = 33° 41′, 320,010 = 56° 19′, 320,001 = 90° 0′.
410,100 = 14° 2′, 410,010 = 75° 58′, 410,001 = 90° 0′.
430,100 = 36° 52′, 430,010 = 53° 8′, 430,001 = 90° 0′.
520,100 = 21° 48′, 520,010 = 68° 12′, 520,001 = 90° 0′.
540,100 = 38° 40′, 540,010 = 51° 20′, 540,001 = 90° 0′.

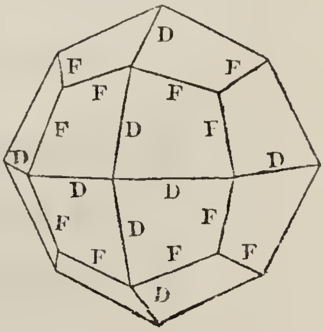
In a combination of the forms 111, $hk0$, the faces of 111 truncate the solid angles of $hk0$, in which the edges F, G meet.

210,111 = 39° 44′. 310,111 = 43° 5′.
320,111 = 36° 49′. 520,111 = 41° 22′.

In a combination of the forms 100, $\pi 0kh$, the faces of 100 truncate the edges D of $\pi 0kh$.

In a combination of the forms 111, $\pi 0kh$, the faces of 111 truncate the solid angles in which the three edges U meet.

FIG. 21.



53. The form hkk, h being greater than k (fig. 21), has twenty-four faces.

$$\cos \text{D} = \frac{h^2}{h^2 + 2k^2},$$

$$\cos \text{F} = \frac{2hk + k^2}{h^2 + 2k^2}.$$

In the form 211, D = 48° 11′, F = 33° 33′.

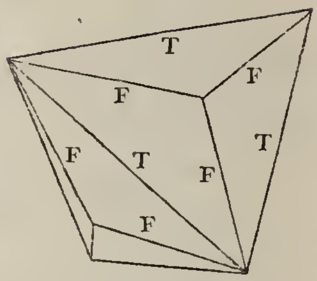
In the form 311, D = 35° 6′, F = 50° 29′.

54. In the form κhkk (fig. 22),

$$\cos F = \frac{2hk + k^2}{h^2 + 2k^2},$$

$$\cos T = \frac{h^2 - 2k^2}{h^2 + 2k^2}.$$

FIG. 22.



In the form κ211, F = 33° 33′, T = 70° 32′.

In the form κ311, F = 50° 29′, T = 50° 29′.

55. In a combination of the forms 100, hkk, three faces of hkk, forming the solid angle in which the three edges F meet, appear upon each of the angles of 100.

211,100 = 35° 16′, 211,010 = 65° 54′, 211,001 = 65° 54′.

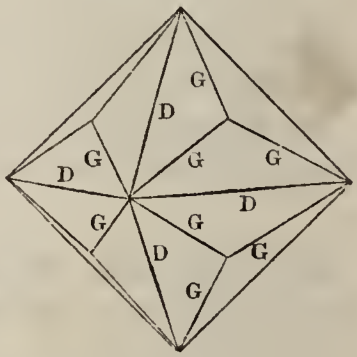
311,100 = 25° 14′, 311,010 = 72° 27′, 311,001 = 72° 27′.

In a combination of the forms 100, κhkk, three faces of the latter, forming the solid angle in which the three edges F meet, appear upon each alternate angle of 100.

In a combination of the forms 111, hkk, the faces of 111 truncate the solid angles of hkk in which the edges F meet.

211,111 = 19° 28′. 311,111 = 29° 30.

FIG. 23.



56. The form khh, h being greater than k (fig. 23), has twenty-four faces.

$$\cos D = \frac{2h^2 - k^2}{2h^2 + k^2},$$

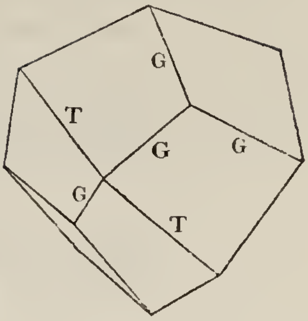
$$\cos G = \frac{h^2 + 2hk}{2h^2 + k^2}.$$

In the form 122, D = 38° 57′, G = 27° 16′.

In the form 133, D = 26° 32′, G = 37° 52′.

In the form 233, D = 50° 29′, G = 17° 20′.

FIG. 24.



57. In the form κkhh (fig. 24),

$$\cos G = \frac{h^2 + 2hk}{2h^2 + k^2},$$

$$\cos T = \frac{h^2 - 2hk}{2h^2 + k^2}.$$

In the form $\kappa 122$, G = 27° 16′, T = 90° 0′.

58. In a combination of the forms 100 and khh, three faces of khh, forming the solid angle in which the three edges G meet, appear upon each of the angles of 100.

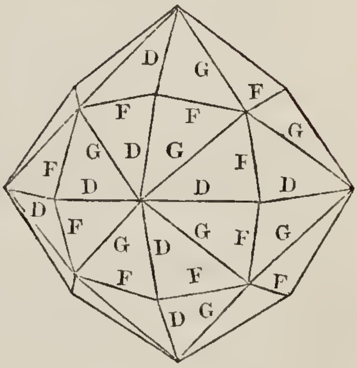
122,100 = 70° 32′, 122,010 = 48° 11′, 122,001 = 48° 11′.
133,100 = 76° 44′, 133,010 = 46° 30′, 133,001 = 46° 30′.
233,100 = 64° 46′, 233,010 = 50° 14′, 233,001 = 50° 14′.

In a combination of the forms 100 and κkhh, three faces of the latter, forming the solid angle in which the three edges G meet, appear upon each alternate angle of 100.

In a combination of the forms 111 and khh, the pairs of faces of the latter that intersect in D, truncate the edges of 111.

122,111 = 15° 48′. 133,111 = 22° 0′. 233,111 = 10° 1′.

FIG. 25.



59. The form hkl (fig. 25) has forty-eight faces.

$$\cos D = \frac{h^2 + k^2 - l^2}{h^2 + k^2 + l^2},$$

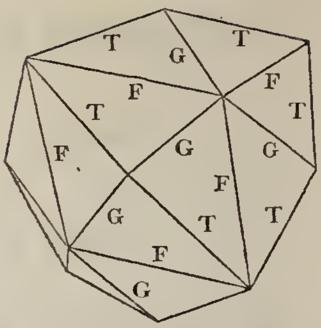
$$\cos F = \frac{2hk + l^2}{h^2 + k^2 + l^2},$$

$$\cos G = \frac{h^2 + 2kl}{h^2 + k^2 + l^2}.$$

In the form 321, D = 31° 0′, F = 21° 47′, G = 21° 47′.
In the form 431, D = 22° 37′, F = 15° 57′, G = 32° 12′.
In the form 421, D = 25° 13′, F = 35° 57′, G = 17° 45′.
In the form 731, D = 14° 58′, F = 43° 13′, G = 21° 13′.

60. In the form κhkl (fig. 26),

FIG. 26.



$$\cos\text{F} = \frac{2hk + l^2}{h^2 + k^2 + l^2},$$

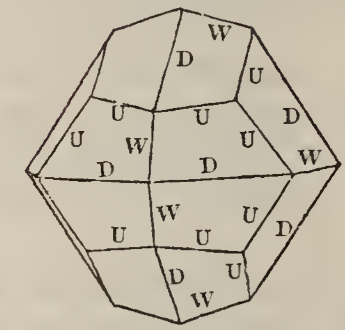
$$\cos\text{G} = \frac{h^2 + 2kl}{h^2 + k^2 + l^2},$$

$$\cos\text{T} = \frac{h^2 - 2kl}{h^2 + k^2 + l^2}.$$

In the form $\kappa 321$, F = 21° 47′, G = 21° 47′, T = 69° 5′.
In the form $\kappa 531$, F = 27° 40′, G = 27° 40′, T = 57° 7′.

61. In the form πlkh (fig. 27),

FIG. 27.



$$\cos\text{D} = \frac{h^2 + k^2 - l^2}{h^2 + k^2 + l^2},$$

$$\cos\text{W} = \frac{h^2 - k^2 + l^2}{h^2 + k^2 + l^2},$$

$$\cos\text{U} = \frac{kl + lh + hk}{h^2 + k^2 + l^2}.$$

In the form $\pi 123$, D = 30° 0′, W = 64° 37′, U = 38° 13′.
In the form $\pi 124$, D = 25° 13′, W = 51° 45′, U = 48° 11′.
In the form $\pi 135$, D = 19° 28′, W = 60° 56′, U = 48° 55′.

62. In a combination of the forms 100, hkl, six faces of hkl, forming the solid angle in which the edges F, G meet, appear upon each of the angles of 100.

321,100 = 36° 42′, 321,010 = 57° 41′, 321,001 = 74° 30′.
421,100 = 29° 12′, 421,010 = 64° 7′, 421,001 = 77° 24′.
431,100 = 38° 20′, 431,010 = 53° 58′, 431,001 = 78° 41′.
531,100 = 32° 19′, 531,010 = 59° 32′, 531,001 = 80° 16′.
731,100 = 24° 18′, 731,010 = 67° 1′, 731,001 = 82° 31′.

In a combination of the forms 100 and κhkl, six faces of the latter, forming the solid angle in which the edges F, G meet, appear upon the alternate angles of 100.

In a combination of the forms 100 and πlkh, three faces of πlkh, forming the solid angle in which the edges U meet, appear upon each of the angles of 100.

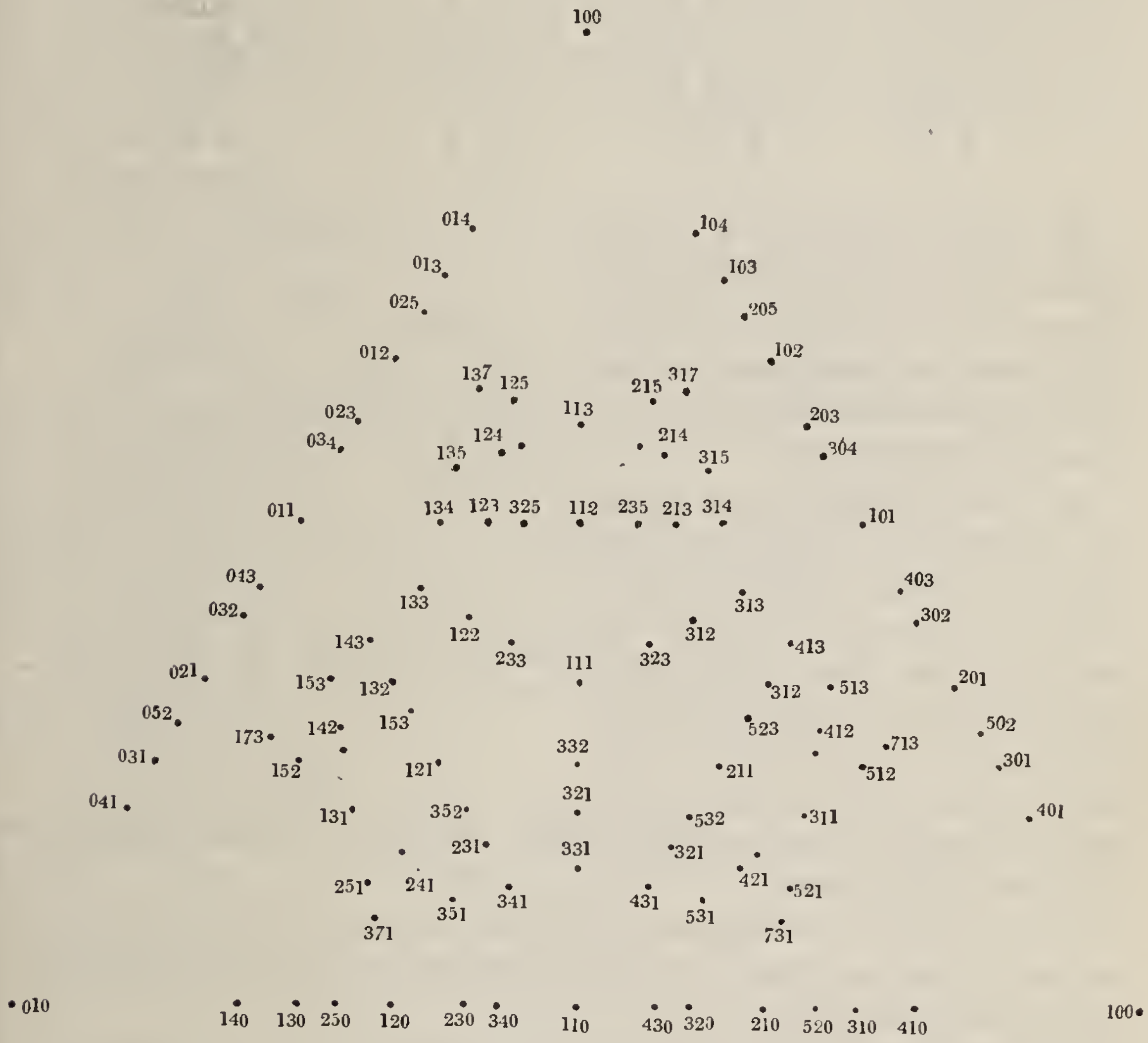
In a combination of the forms 111 and hkl, or κhkl, the faces of 111 truncate the solid angles in which the edges F, G meet.

321,111 = 22° 13′. 421,111 = 28° 8′. 431,111 = 25° 4′.
531,111 = 28° 35′. 731,111 = 34° 14′.

In a combination of the forms 111 and πlkh, the faces of 111 truncate the solid angles of the latter, in which the edges U meet.

63. Fig. 28 shows the arrangement of the poles of the faces of the preceding forms on an octant of the sphere of projection.

FIG. 28.



Of the preceding forms, those which have the simplest indices—the cube 100, octahedron 111, and dodecahedron 011, occur much more frequently than the others. It does not appear that any cleavages have been observed except parallel to the faces of one or more of the forms 100, 111, 011.

PYRAMIDAL SYSTEM.

64. In the pyramidal system, the crystallographic axes make right angles with each other, and the first and second parameters are equal.

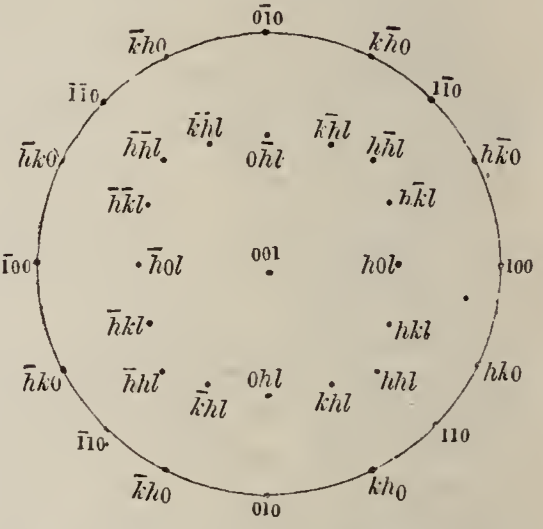
65. The form hkl is bounded by all the faces which have for their symbols the different arrangements of $\pm h$, $\pm k$, $\pm l$, in which l holds the last place. When h and k are different, they

afford the sixteen arrangements contained in the annexed table. When one of the indices is zero, or when $h = k$, the number will be eight. When l is zero, and $h = k$, or when one of the indices h, k is zero, the number will be four. When h and k are zero, it will be two.

$h\,k\,l$	$\bar{h}\,k\,\bar{l}$	$\bar{k}\,h\,l$	$\bar{k}\,\bar{h}\,\bar{l}$
$\bar{h}\,\bar{k}\,l$	$h\,\bar{k}\,\bar{l}$	$k\,\bar{h}\,l$	$k\,h\,\bar{l}$
$\bar{k}\,h\,\bar{l}$	$k\,h\,l$	$\bar{h}\,\bar{k}\,\bar{l}$	$\bar{h}\,k\,l$
$k\,\bar{h}\,\bar{l}$	$\bar{k}\,\bar{h}\,l$	$h\,k\,\bar{l}$	$h\,\bar{k}\,l$

66. If we suppose h to be greater than k, the annexed figure will represent the arrangement of the poles of the form hkl on the surface of the sphere of projection.

FIG. 29.



67. The form bounded either by all the faces of the form hkl which have an odd number of positive indices, or by all the faces of the form hkl which have an odd number of negative indices, is said to be hemihedral with inclined faces, and will be denoted by the symbol κhkl, where hkl is the symbol of any one of its faces.

The symbols of the faces of κhkl are contained in the first and second columns; those of $\kappa\bar{h}\bar{k}\bar{l}$ in the third and fourth columns of the table in (65).

If the surface of the sphere of projection be divided into eight triangles by zone-circles through the poles of the forms 001 and 100, the poles of κhkl will be found in four alternate triangles, one of which contains the pole of the face 111. The poles of the form $\kappa\bar{h}\bar{k}\bar{l}$ will be contained in the remaining four alternate triangles.

68. The pyramidal system admits of a second hemihedral form with inclined faces, which is bounded by all the faces of the form hkl in which the order of h, k changes with the sign of l, and which will be denoted by the symbol λhkl, where hkl is the symbol of any one of its faces. The symbols of the faces of the form λhkl are contained in the first and fourth columns; those of λkhl in the second and third columns of the table in (65).

If the surface of the sphere of projection be divided into eight triangles by great circles through the poles of the forms 001 and 110, the poles of λhkl will be found in four alternate triangles, and the poles of the form λkhl in the remaining four alternate triangles.

69. The form bounded by all the faces of the form hkl, in which the order of h, k is the same or different, according as h, k have the same or different signs, is said to be hemihedral with parallel faces, and will be denoted by the symbol πhkl, where hkl is the symbol of any one of its faces. The symbols of the faces of the form πhkl are contained in the first and third columns; those of πkhl in the second and fourth columns of the table in (65).

If the surface of the sphere of projection be divided into eight lunes by zone-circles through the poles of the forms 100, 110, the poles of πhkl will be found in four alternate lunes; and those of πkhl in the remaining four alternate lunes.

70. The form bounded by all the faces of the form hkl, in which the order of the indices h, k is the same or different according as an odd number of the indices are positive or negative, is said to be hemihedral with asymmetric faces, and will be denoted by the symbol $ahkl$, where hkl is the symbol of any one of its faces. The upper and lower halves of the table in (65), contain the symbols of the faces of $ahkl$, $akhl$ respectively.

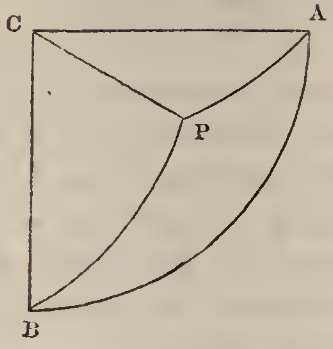
The poles of $ahkl$ are the eight alternate poles of the form hkl; and the poles of $akhl$ are the remaining eight alternate poles of the form hkl.

71. The poles of the form hkl are symmetrically arranged with respect to each of the five zone-circles drawn through the poles of every two of the forms 001, 100, 110. The poles of κhkl are symmetrically arranged with respect to the two zone-circles drawn through the poles of the form 001, and those of the form 110. The poles of λhkl are symmetrically arranged with respect to the two zone-circles through the poles of the form 001, and those of the form 100. The poles of πhkl are symmetrically arranged with respect to the zone-circle passing through the poles of the form 100.

72. The two hemihedral forms, either with inclined or with parallel faces, derived from the same holohedral form, are identical in all respects, position excepted; for by making the sphere of projection revolve through two right angles round two opposite poles of the form 100, the poles of κhkl and πhkl come into the places of those of $\kappa\bar{h}\bar{k}\bar{l}$ and πkhl respectively; and by making it revolve through two right angles round two opposite poles of the form 110, the poles of λhkl come into the places of those of λkhl. The two hemihedral forms $ahkl$, $akhl$ are essentially different.

73. To find the position of any pole.

FIG. 30.



Let A, B, C be the poles of 100, 010, 001; E the distance between the poles of 101, 001; P the pole of *hkl*.

BC, CA, AB are quadrants.

$$\tan \mathrm{PAB} = \frac{l}{k} \cot \mathrm{E},$$

$$\tan \mathrm{PBA} = \frac{l}{h} \cot \mathrm{E},$$

$$\tan \mathrm{PCA} = \frac{k}{h}.$$

$$\cot \mathrm{PA} = \frac{h}{k} \cos \mathrm{PAB} = \frac{h}{l} \tan \mathrm{E} \cos \mathrm{PAC}.$$

$$\cot \mathrm{PB} = \frac{k}{h} \cos \mathrm{PBA} = \frac{k}{l} \tan \mathrm{E} \cos \mathrm{PBC}.$$

$$\cot \mathrm{PC} = \frac{l}{h} \cot \mathrm{E} \cos \mathrm{PCA} = \frac{l}{k} \cot \mathrm{E} \cos \mathrm{PCB}.$$

$$\tan \mathrm{PC} = \frac{\sqrt{(h^2 + k^2)}}{l} \tan \mathrm{E}.$$

E is the angular element of a crystal belonging to the pyramidal system.

74. In the form *hk*0, let the distance between two poles be K, F or M, according as their symbols differ only in the sign of *k*, the order of the indices *h*, *k*, or in the order of the indices *h*, *k*, and the signs of *h* or *k*. Then

$$\tan \tfrac{1}{2}\mathrm{K} = \frac{k}{h}, \quad \mathrm{F} = 90^\circ - \mathrm{K}, \quad \mathrm{M} = 90^\circ.$$

75. In the form *h*0*l*, let L be the distance between two poles differing only in the sign of *l*, F the distance between two poles differing only in the arrangement of *h*, 0, E the distance between the poles 001, 101. Then

$$\tan \tfrac{1}{2}\mathrm{L} = \frac{l}{h} \cot \mathrm{E}, \quad \cos \mathrm{F} = (\sin \tfrac{1}{2}\mathrm{L})^2.$$

76. In the form *hhl*, let K, L be the distances between two poles differing only in the signs of *h*, *l* respectively. Then

$$\tan \tfrac{1}{2}\mathrm{L} = \frac{l}{h} \cos 45^\circ \cot \mathrm{E}, \quad \cos \mathrm{K} = (\sin \tfrac{1}{2}\mathrm{L})^2.$$

77. Let H, K, L be the distances between any two poles of the form *hkl*, differing only in the signs of h, k, l respectively. Let F be the distance between any two poles having the indices h, k in different order, and the signs of the first, second, and third indices in one, the same as the signs of the first, second, and third indices in the other. Let G be the distance between any two poles having the indices h, k in different order, the signs of the first and second indices in one, different from the signs of the first and second indices in the other, the sign of the third index being the same in both; and let M be the distance between any two poles differing only in the order of the indices h, k, and in the sign of one of them. Then

$$\tan\phi = \frac{k}{h}, \quad \tan\tfrac{1}{2}\mathrm{L} = \frac{l}{h}\cot\mathrm{E}\cos\phi,$$

$$\sin\tfrac{1}{2}\mathrm{K} = \cos\tfrac{1}{2}\mathrm{L}\sin\phi, \quad \sin\tfrac{1}{2}\mathrm{H} = \cos\tfrac{1}{2}\mathrm{L}\cos\phi,$$

$$\sin\tfrac{1}{2}\mathrm{G} = \cos\tfrac{1}{2}\mathrm{L}\sin(45^\circ + \phi),$$

$$\sin\tfrac{1}{2}\mathrm{F} = \cos\tfrac{1}{2}\mathrm{L}\cos(45^\circ + \phi),$$

$$\cos\mathrm{M} = (\sin\tfrac{1}{2}\mathrm{L})^2.$$

78. If the distance between two poles of either of the forms *hk*0, *h*0*l*, *hhl* be given, the distance between the two poles, or its supplement, will be one of the arcs F, K, L, whence, from the expressions in (74), (75), (76), the indices may be found.

If the distance between any pole of the form *hkl* and each of two other poles of the same form be given, the three poles not being in a great circle, the given distances, or their supplements, will be two of the arcs H, K, L, F, G, M, which being known, ϕ and L, and thence, from the expressions in (77), the indices may be found.

79. Let A, B, C be the poles of 100, 010, 001 respectively; P the pole of *hkl*, Q that of *pqr*.

Let Q be in the zone-circle PA. Then

$$\frac{\tan\mathrm{PA}}{\tan\mathrm{QA}} = \frac{pk}{hq} = \frac{pl}{hr}.$$

Let Q be in the zone-circle PB. Then

$$\frac{\tan\mathrm{PB}}{\tan\mathrm{QB}} = \frac{ql}{kr} = \frac{qh}{kp}.$$

Let Q be in the zone-circle PC. Then

$$\frac{\tan\mathrm{PC}}{\tan\mathrm{QC}} = \frac{rh}{lp} = \frac{rk}{lq}.$$

80. Let P be the pole of *hkl*, Q the pole of *pqr*, C the pole of 001. Then

$$\frac{l}{\sqrt{(h^2+k^2)}}\tan \mathrm{PC} = \frac{r}{\sqrt{(p^2+q^2)}}\tan \mathrm{QC}.$$

81. To find the distance between any two poles.

Let A, B, C be the poles of the faces 100, 010, 001; P, Q the poles of *hkl*, *pqr*; and let PQ meet AB in M. Then, *h*, *k*, *l*, *p*, *q*, *r* being known, the symbol of M is known by (19), (20). tan PCA, tan QCA, tan MCA are known by (73). Therefore PCM, QCM are known.

$$\tan \mathrm{PC} = \frac{\sqrt{(h^2+k^2)}}{l}\tan \mathrm{E}.$$

$$\cos \mathrm{PM} = \cos \mathrm{PCM} \sin \mathrm{PC}.$$

$$\frac{\tan \mathrm{QM}}{\tan \mathrm{PM}} = \frac{\tan \mathrm{QCM}}{\tan \mathrm{PCM}}.$$

Whence PQ, which is either the sum or difference of PM, QM, is known.

82. Having given the distance between any two poles, not both in the zone-circle 100, 010, to find E, the distance between the poles 101, 001, or the angular element of the crystal.

Let *hkl*, *pqr* be the symbols of P, Q, M the intersection of the zone-circles PQ, AB. Then PCM, QCM are known by (19), (20), and (73).

$$\frac{\sin(\mathrm{QM}+\mathrm{PM})}{\sin(\mathrm{QM}-\mathrm{PM})} = \frac{\sin(\mathrm{QCM}+\mathrm{PCM})}{\sin(\mathrm{QCM}-\mathrm{PCM})}.$$

The given distance PQ is either QM + PM or QM − PM, therefore PM, QM are known.

$$\cos \mathrm{PM} = \cos \mathrm{PCM} \sin \mathrm{PC}.$$

$$\tan \mathrm{E} = \frac{l}{\sqrt{(h^2+k^2)}}\tan \mathrm{PC}.$$

83. To change the axes.

Let the new axes be the axes of the zones containing every two of the faces 110, $1\bar{1}0$, 001. Then, *u*, *v*, *w* being the indices of a face when referred to the old axes, *u′*, *v′*, *w′* its indices when referred to the new axes,

$$u' = u + v, \quad v' = u - v, \quad w' = w.$$

84. To determine the figure and angles of the form *hkl*, when *h*, *k*, *l* take particular values.

The angle between normals to any two faces is obtained from the expressions in (74), (75), (76), (77), and will be denoted by the letter which, in the accompanying figure, is placed upon the edge in which the given faces intersect. The arrangement of the poles of the different forms is shown in fig. 29. The number of faces is given in (65).

85. The form 001 has two parallel faces.

86. The form 100 (fig. 31) has four faces, of which the opposite faces are parallel, and the adjacent faces perpendicular to each other.

$$\text{F} = 90^\circ.$$

87. The form 110 (fig. 32) has four faces, of which the opposite faces are parallel, and the adjacent faces perpendicular to each other.

$$\text{K} = 90^\circ.$$

88. In a combination of the forms 100 and 110, the faces of one form truncate the edges of the other.

A normal to a face of one of the above forms makes an angle of 45° with normals to the adjacent faces of the other.

In combinations of the forms 100, 110 with the form 001, the faces of 100, 110, make right angles with the faces of 001.

FIG. 31.

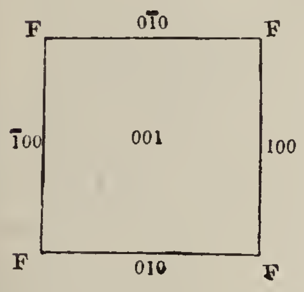


FIG. 32.

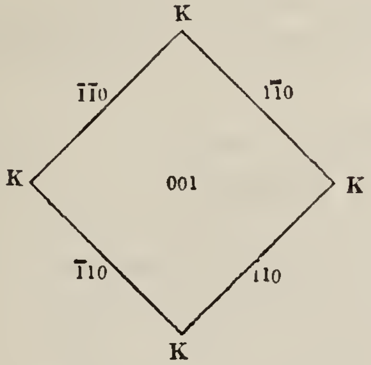
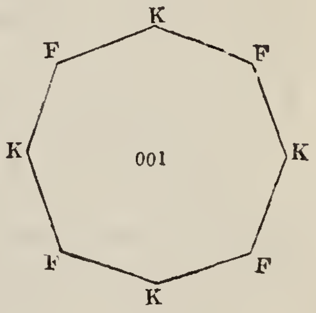


FIG. 33.



89. The form *hk*0 (fig. 33) has eight faces in one zone.

$$\tan \tfrac{1}{2}\text{K} = \frac{k}{h}, \quad \text{F} = 90^\circ - \text{K}.$$

In the form 210, K = 53° 8′, F = 36° 52′.
In the form 310, K = 36° 52′, F = 53° 8′.
In the form 320, K = 67° 23′, F = 22° 37′.
In the form 430, K = 73° 44′, F = 16° 16′.
In the form 510, K = 22° 37′, F = 67° 23′.
In the form 530, K = 61° 56′, F = 28° 4′.
In the form 710, K = 16° 16′, F = 73° 44′.

90. In a combination of the forms $hk0$, 001, the faces of the form $hk0$ make right angles with those of the form 001.

In combinations of the form $hk0$ with the forms 100, 110, the faces of 100 truncate the edges K, the faces of 110 truncate the edges F.

A normal to any face of the form $hk0$ makes with normals to the nearest faces of 100, 110 angles $\frac{1}{2}$K, $\frac{1}{2}$F respectively.

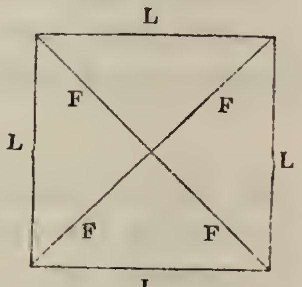
91. The form $\pi hk0$, bounded by the alternate faces of the form $hk0$, has four faces, of which any two opposite faces are parallel, and any two adjacent faces are perpendicular to each other.

92. The form $h0l$ (fig. 34) has eight faces.

$$\tan\tfrac{1}{2}\mathrm{L} = \frac{l}{h}\cot\mathrm{E},$$

$$\cos\mathrm{F} = (\sin\tfrac{1}{2}\mathrm{L})^2.$$

FIG. 34.



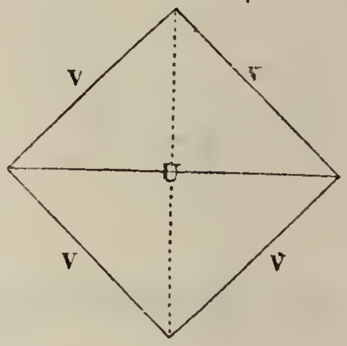
93. In combinations of the form $h0l$ with the forms 001, 100, 110, the faces of 001 truncate the solid angles in which the edges F meet; the faces of 100 truncate the edges L, and the faces of 110 truncate the solid angles in which the edges L, F meet.

$$h0l,001 = 90^\circ - \tfrac{1}{2}\mathrm{L},$$
$$h0l,100 = \tfrac{1}{2}\mathrm{L},$$
$$\cos(h0l,110) = \cos 45^\circ \cos\tfrac{1}{2}\mathrm{L}.$$

94. In the form $\lambda h0l$ (fig. 35),

$$\mathrm{U} = 180^\circ - \mathrm{L}, \quad \mathrm{V} = 180^\circ - \mathrm{F}.$$

FIG. 35.



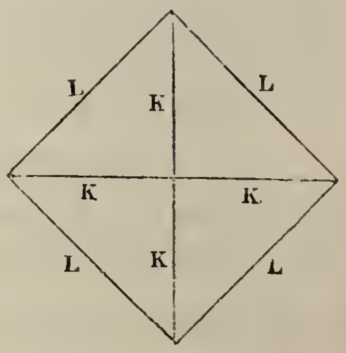
95. In combinations of the form $\lambda h0l$ with the forms 001, 100, 110, the faces of 001 truncate the edges U; the faces of 110 truncate the edges V; and the faces of 100 truncate the solid angles in which the edges U, V meet.

96. The form hhl (fig. 36) has eight faces.

$$\tan\tfrac{1}{2}\mathrm{L} = \frac{l}{h}\cos 45^\circ \cot\mathrm{E},$$

$$\cos\mathrm{K} = (\sin\tfrac{1}{2}\mathrm{L})^2.$$

FIG. 36.



97. In combinations of the form hhl with the forms 001, 100, 110, the faces of 001 truncate the solid angles in which the four edges K meet; the

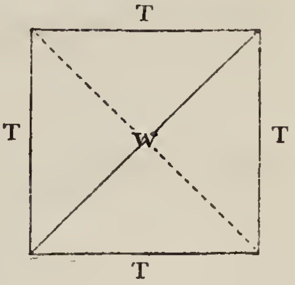
faces of 100 truncate the solid angles in which the edges K, L meet; and the faces of 110 truncate the edges L.

$$hhl,001 = 90^\circ - \tfrac{1}{2}\mathrm{L};$$
$$\cos(hhl,100) = \cos 45^\circ \cos\tfrac{1}{2}\mathrm{L};$$
$$hhl,100 = \tfrac{1}{2}\mathrm{L}.$$

98. In the form κhhl (fig. 37),

$$\mathrm{W} = 180^\circ - \mathrm{L}, \quad \mathrm{T} = 180^\circ - \mathrm{K}.$$

FIG. 37.



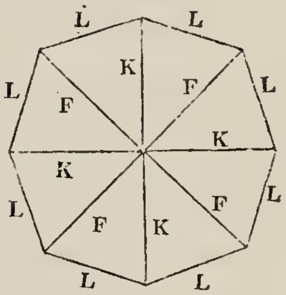
99. In combinations of the form κhhl with the forms 001, 100, 110, the faces of 001 truncate the edges W; the faces of 100 truncate the edges T; and the faces of 110 truncate the solid angles in which the edges T, W meet.

100. Let P, Q be two adjacent poles of one of the forms hhl, por, equidistant from C the pole of 001; and let the arc PQ contain S, a pole of the other form. Then,

$$\tan \mathrm{SC} = \cos 45^\circ \tan \mathrm{PC}.$$

101. The form hkl (fig. 38) has sixteen faces.

FIG. 38.

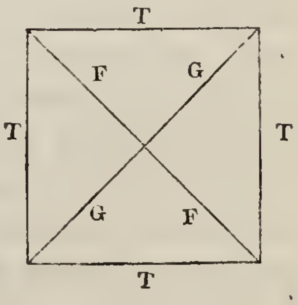


$$\tan\phi = \frac{k}{h}, \quad \tan\tfrac{1}{2}\mathrm{L} = \frac{l}{h}\cot\mathrm{E}\,\cos\phi,$$
$$\sin\tfrac{1}{2}\mathrm{K} = \cos\tfrac{1}{2}\mathrm{L}\sin\phi,$$
$$\sin\tfrac{1}{2}\mathrm{F} = \cos\tfrac{1}{2}\mathrm{L}\cos(45^\circ + \phi),$$

102. In combinations of the form hkl with the forms 001, 100, 110, the faces of 001 truncate the solid angles in which the edges K, F meet; the faces of 100 truncate the solid angles in which the edges K, L meet; and the faces of 110 truncate the solid angles in which the edges F, L meet.

$$hkl,001 = 90^\circ - \tfrac{1}{2}\mathrm{L};$$
$$\cos(hkl,100) = \cos\tfrac{1}{2}\mathrm{L}\cos\phi;$$
$$\cos(hkl,110) = \cos\tfrac{1}{2}\mathrm{L}\sin(45^\circ + \phi).$$

FIG. 39.



103. In the form κhkl (fig. 39),

$$\sin\tfrac{1}{2}\mathrm{G} = \cos\tfrac{1}{2}\mathrm{L}\sin(45^\circ + \phi),$$
$$\cos\tfrac{1}{2}\mathrm{T} = \cos\tfrac{1}{2}\mathrm{L}\cos\phi.$$

104. In combinations of the form κhkl with the form 100, the faces of 100 truncate the edges T.

105. In the form λhkl (fig. 40),

$$\sin\tfrac{1}{2}\mathrm{H} = \cos\tfrac{1}{2}\mathrm{L}\cos\phi,$$
$$\cos\tfrac{1}{2}\mathrm{V} = \cos\tfrac{1}{2}\mathrm{L}\sin(45^\circ + \phi).$$

106. In combinations of the form λhkl with the form 110, the faces of 110 truncate the edges V.

107. In the form πhkl (fig. 41),

$$\cos\mathrm{M} = (\sin\tfrac{1}{2}\mathrm{L})^2.$$

108. In the form $ahkl$ (fig. 42),

$$\cos\mathrm{M} = (\sin\tfrac{1}{2}\mathrm{L})^2,$$
$$\cos\tfrac{1}{2}\mathrm{T} = \cos\tfrac{1}{2}\mathrm{L}\cos\phi,$$
$$\cos\tfrac{1}{2}\mathrm{V} = \cos\tfrac{1}{2}\mathrm{L}\sin(45^\circ + \phi).$$

109. In combinations of the form $ahkl$ with the forms 100, 110, the faces of 100 truncate the edges T; and the faces of 110 truncate the edges V.

FIG. 40.

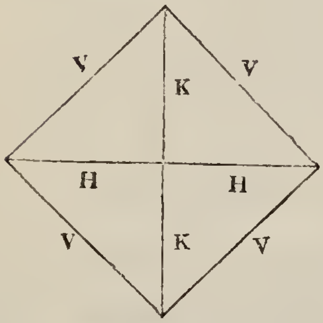


FIG. 41.

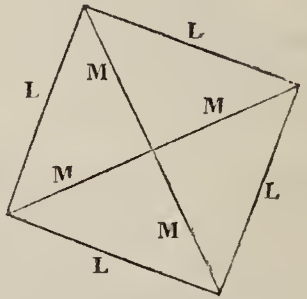
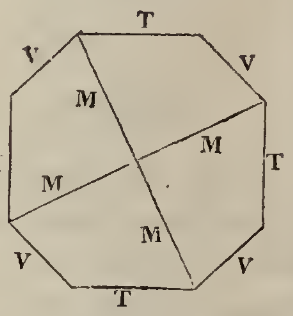


FIG. 42.



110. The cleavages, in crystals belonging to the pyramidal system, are parallel to the faces of one or more of the forms 001, 100, hol, hhl.

RHOMBOHEDRAL SYSTEM.

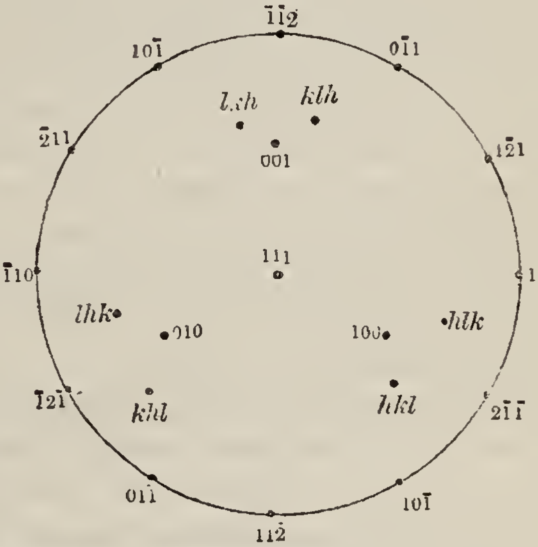
111. In the rhombohedral system the axes make equal angles with each other, and the parameters are equal.

112. The form hkl is bounded by all the faces which have for their symbols the different arrangements of $+h$, $+k$, $+l$, together with those of $-h$, $-k$, $-l$. When h, k, l are all different, the number of arrangements will be twelve, as shown in the annexed table, except when the indices are 0, -1, 1. In this case, and also when two of the indices are equal, the

number will be six; and when all three are equal, the number will be two.

$h\ k\ l$	$l\ k\ h$	$\bar{h}\ \bar{k}\ \bar{l}$	$\bar{l}\ \bar{k}\ \bar{h}$
$k\ l\ h$	$k\ h\ l$	$\bar{k}\ \bar{l}\ \bar{h}$	$\bar{k}\ \bar{h}\ \bar{l}$
$l\ h\ k$	$h\ l\ k$	$\bar{l}\ \bar{h}\ \bar{k}$	$\bar{h}\ \bar{l}\ \bar{k}$

FIG. 43.



113. If h be algebraically the greatest, and l the least of three unequal indices h, k, l, the annexed figure will represent the arrangement of the poles of the form hkl on the surface of the sphere of projection.

114. The form bounded either by all the faces which have for their symbols the different arrangements of $+h$, $+k$, $+l$, or by all the faces which have for their symbols the different arrangements of $-h$, $-k$, $-l$, is said to be hemihedral with inclined faces, and will be denoted by the symbol κhkl, where hkl is the symbol of any one of its faces. The first and second columns of the table in (112) contain the symbols of the form κhkl; the third and fourth columns those of the form $\kappa\bar{h}\bar{k}\bar{l}$.

If the surface of the sphere of projection be divided into two parts by the zone-circle through the poles of the form $10\bar{1}$, one part will contain the poles of κhkl, and the other part the poles of $\kappa\bar{h}\bar{k}\bar{l}$, except when the sum of the indices is zero. When the sum of the indices is zero, three alternate arcs, of the six arcs joining the poles of the form $10\bar{1}$, contain the poles of κhkl; and the other three alternate arcs the poles of $\kappa\bar{h}\bar{k}\bar{l}$.

115. The form bounded either by all the faces of the form hkl, the indices of which stand in the order $hklhk$, or by all the faces the indices of which stand in the order $lkhlk$, is said to be hemihedral with parallel faces, and will be denoted by the symbol πhkl, where hkl is the symbol of any one of its faces. The first and third columns of the table in (112) contain the symbols of the faces of πhkl; the second and fourth those of πlkh.

If the surface of the sphere of projection be divided into twelve lunes by zone-circles through the poles of the forms 111, $2\bar{1}\bar{1}$, $10\bar{1}$, six alternate lunes will contain the poles of πhkl, and the other six alternate lunes those of πlkh, except when the algebraic sum of two of the indices is equal to twice the third index. And if the sphere of projection be divided into twelve triangles by zone-circles through every two of the poles of the forms 111, $2\bar{1}\bar{1}$, six alternate triangles will contain the poles of πhkl; and the other six alternate triangles those of πlkh, except when the sum of the indices is zero.

116. The form bounded either by all the faces of hkl which have for their symbols the arrangements of $+h$, $+k$, $+l$, which stand in the order $hklhk$, and those of $-h$, $-k$, $-l$, which stand in the order $lkhlk$, or by all the faces which have for their symbols the arrangements of $+h$, $+k$, $+l$, which stand in the order $lkhlk$, and those of $-h$, $-k$, $-l$, which stand in the order $hklhk$, is said to be hemihedral with asymmetric faces, and will be denoted by the symbol αhkl, where hkl is the symbol of any one of its faces.

The first and fourth columns of the table in (112) contain the symbols of the faces of αhkl; the second and third columns those of αlkh.

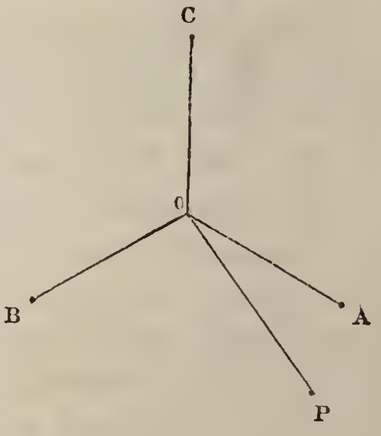
If the surface of the sphere of projection be divided into six lunes by zone-circles through the poles of the forms 111 and $2\bar{1}\bar{1}$, three alternate lunes will contain the poles of αhkl, and the remaining three alternate lunes the poles of αlkh.

117. To determine the position of any pole.

Let O be the pole of 111; A, B, C the poles of 100, 010, 001; P the pole of hkl.

$\text{OA} = \text{OB} = \text{OC} = \text{D}$, $\text{BC} = \text{CA} = \text{AB}$, and the angles BOC, COA, AOB are each equal to 120°.

FIG. 44.



$$\tan \text{POA} = \sqrt{3}\,\frac{k-l}{2h-k-l},$$

$$\tan \text{POB} = \sqrt{3}\,\frac{l-h}{2k-l-h},$$

$$\tan \text{POC} = \sqrt{3}\,\frac{h-k}{2l-h-k},$$

$$\tan \text{PO} = \frac{\sqrt{\{\frac{1}{2}[(k-l)^2+(l-h)^2+(h-k)^2]\}}}{h+k+l}\tan \text{D}.$$

D is the angular element of a crystal belonging to the rhombohedral system.

118. Let *hkk*, *pqr* be any two faces in a zone containing 111. Then

$$\frac{k-l}{h+k+l}\tan(hkl,111) = \frac{q-r}{p+q+r}\tan(pqr,111).$$

119. Let $0vw$ be any face in the zone containing 010, 011. Then

$$\tan(0vw,01\bar{1}) = \frac{v+w}{v-w}\tan(010,01\bar{1}).$$

120. Let $uv\bar{v}$ be any face in a zone containing $11\bar{1}$, $01\bar{1}$. Then

$$\tan(uv\bar{v},01\bar{1}) = \frac{u}{v}\tan(11\bar{1},01\bar{1}).$$

121. When h, k, l, p, q, r are connected by the equations,

$$p = -h+2k+2l, \quad q = 2h-k+2l, \quad r = 2h+2k-l,$$

the arc joining the poles *hkl*, *pqr*, is bisected in the pole 111. The forms *hkl*, *pqr* are, in this case, said to be transverse with respect to each other.

In certain crystals belonging to the rhombohedral system, combinations of pairs of transverse forms occur frequently. Such a combination is called dirhombohedral. It may be denoted by the symbol δhkl, where *hkl* is the symbol of either of the two forms.

The poles of the form *hkl* are symmetrically situated with respect to each of the three zone-circles through the poles of the forms 111, $2\bar{1}\bar{1}$. The poles of the dirhombohedral combination of forms *hkl*, *pqr* are symmetrically situated with respect to each of seven zone-circles through every two of the poles of the forms 111, $2\bar{1}\bar{1}$, $10\bar{1}$.

122. The two hemihedral forms, either with inclined or with parallel faces, derived from the same holohedral form, are identical in all respects, position excepted; for, if the sphere of projection be made to revolve through two right angles round any two opposite poles of the form $10\bar{1}$, the poles of κhkl come into the places of those of $\kappa\bar{h}\bar{k}\bar{l}$, and the poles of πhkl come into the places of the poles of πlkh. The forms αhkl, $alkh$ are essentially different.

123. Let P, A be any two adjacent poles of the forms *hkk*, 100 respectively, O the nearest pole of the form 111, PO = T, AO = D, the angular element of a crystal belonging to the rhombohedral system. Then

$$\tan \mathrm{T} = \frac{h-k}{h+2k}\tan \mathrm{D}.$$

The signs of tan T, tan D, will be the same or different, according as the directions in which PO, AO are measured from O, are the same or different.

124. If V be the distance between any two of three poles of the form hkk, which have the indices h, k, k,

$$\sin\tfrac{1}{2}\mathrm{V} = \sin 60^\circ \sin \mathrm{T}.$$

The distance between any two adjacent poles, one of which has the indices $+h$, $+k$, $+l$, and the other the indices $-h$, $-k$, $-l$, will be 180° − V.

125. If P be any pole of the form hkl, where $h + k + l = 0$, PO = 90°, and if H be the distance between any two adjacent poles of hkl having the indices h, k, l,

$$\tan\tfrac{1}{2}\mathrm{H} = \sqrt{3}\frac{k - l}{2h - k - l}.$$

126. Let the arc adjoining any two poles of the form hkl, having the indices $+h$, $+k$, $+l$, be H, K, L or V, according as h, k, l, or neither of the indices, holds the same place in the symbols of the two poles; T the distance of either of the poles from 111; D the distance of any pole of the form 100 from the nearest pole of the form 111; 2θ, 2ϕ, 2ψ the angles subtended at 111 by H, K, L. The angle subtended by V will be 120°. Then

$$\tan \mathrm{T} = \frac{\sqrt{\{\frac{1}{2}[(k-l)^2 + (l-h)^2 + (h-k)^2]\}}}{h + k + l}\tan \mathrm{D},$$

$$\tan\theta = \sqrt{3}\frac{k - l}{2h - k - l},$$

$$\tan\phi = \sqrt{3}\frac{l - h}{2k - l - h},$$

$$\tan\psi = \sqrt{3}\frac{h - k}{2l - h - k}.$$

$$\sin\tfrac{1}{2}\mathrm{H} = \sin\theta\sin \mathrm{T}, \quad \sin\tfrac{1}{2}\mathrm{K} = \sin\phi\sin \mathrm{T},$$

$$\sin\tfrac{1}{2}\mathrm{L} = \sin\psi\sin \mathrm{T}, \quad \sin\tfrac{1}{2}\mathrm{V} = \sin 60^\circ\sin \mathrm{T}.$$

127. If V, the distance between any two of three equidistant poles of the form hkk, be given, we have

$$\sin\tfrac{1}{2}\mathrm{V} = \sin 60^\circ\sin \mathrm{T}, \quad \tan \mathrm{T} = m\tan \mathrm{D},$$

$$(h - k) = \pm\, m(h + 2k),$$

the upper or lower sign being taken according as T and D are measured from 111 in the same, or in different directions. Whence, m being known, h and k may be found.

128. In the form hkl, where $h+k+l=0$, the distance between any two poles, not a multiple of 60°, being known, we can find the distance of one of them from the nearest pole of the form $2\bar{1}\bar{1}$. If this distance be θ, h, k, l may be found from the equations

$$\tan\theta = \sqrt{3}\,\frac{k-l}{2h-k-l}, \quad h+k+l=0.$$

129. If the distances between any pole of the form hkl and each of two other poles of the same form be given, the three poles not being in one zone-circle, the given distances, or their supplements, will be two of the arcs H, K, L, V.

$$\frac{\tan\theta}{\tan 60^\circ} = \frac{\tan\frac{1}{4}(\mathrm{K}-\mathrm{L})}{\tan\frac{1}{4}(\mathrm{K}+\mathrm{L})}, \quad \frac{\sin\theta}{\sin 60^\circ} = \frac{\sin\frac{1}{2}\mathrm{H}}{\sin\frac{1}{2}\mathrm{V}},$$

$$\frac{\tan\phi}{\tan 60^\circ} = \frac{\tan\frac{1}{4}(\mathrm{L}+\mathrm{H})}{\tan\frac{1}{4}(\mathrm{L}-\mathrm{H})}, \quad \frac{\sin\phi}{\sin 60^\circ} = \frac{\sin\frac{1}{2}\mathrm{K}}{\sin\frac{1}{2}\mathrm{V}},$$

$$\frac{\tan\psi}{\tan 60^\circ} = \frac{\tan\frac{1}{4}(\mathrm{K}-\mathrm{H})}{\tan\frac{1}{4}(\mathrm{K}+\mathrm{H})}, \quad \frac{\sin\psi}{\sin 60^\circ} = \frac{\sin\frac{1}{2}\mathrm{L}}{\sin\frac{1}{2}\mathrm{V}}.$$

Two of the four distances H, K, L, V being known, T and one of the angles θ, ϕ, ψ may be found; and then the indices may be found from the equations

$$\tan\theta = \sqrt{3}\,\frac{k-l}{2h-k-l}, \quad 2\tan\mathrm{T}\cos\theta = \frac{2h-k-l}{h+k+l}\tan\mathrm{D},$$

$$\tan\phi = \sqrt{3}\,\frac{l-h}{2k-l-h}, \quad 2\tan\mathrm{T}\cos\phi = \frac{2k-l-h}{h+k+l}\tan\mathrm{D},$$

$$\tan\psi = \sqrt{3}\,\frac{h-k}{2l-h-k}, \quad 2\tan\mathrm{T}\cos\psi = \frac{2l-h-k}{h+k+l}\tan\mathrm{D}.$$

130. To find the distance between any two poles.

Let P, Q be the poles of hkl, pqr; O, A the poles of 111, 100; OA = D. Let PQ meet the zone-circle through the poles of the form $10\bar{1}$ in M. Then, h, k, l, p, q, r being known, the symbol of M is known by (19), (20). tan MOA, tan POA, tan QOA are known by (117). Therefore POM, QOM are known. PO is given in terms of D by (117).

$$\cos \text{PM} = \cos \text{POM} \sin \text{PO},$$

$$\frac{\tan \text{QM}}{\tan \text{PM}} = \frac{\tan \text{QOM}}{\tan \text{POM}}.$$

Whence PQ, which is either the sum or difference of PM, QM, is known.

131. Having given the distance between any two poles, not both in the zone-circle through the poles of the form $10\bar{1}$, to find D, the distance of any pole of the form 100 from the nearest pole of the form 111.

Let P, Q be the given poles, hkl, pqr their symbols; then retaining the construction in (130), h, k, l, p, q, r being known, POM, QOM are known.

$$\frac{\sin(\text{QM} + \text{PM})}{\sin(\text{QM} - \text{PM})} = \frac{\sin(\text{QOM} + \text{POM})}{\sin(\text{QOM} - \text{POM})}.$$

One of the arcs QM − PM, QM + PM is the given distance PQ. Therefore PM, QM are both known.

$$\cos \text{PM} = \cos \text{POM} \sin \text{PO}.$$

PO being known, D is given by the equation

$$\tan \text{PO} = \frac{\sqrt{\{\tfrac{1}{2}[(k-l)^2 + (l-h)^2 + (h-k)^2]\}}}{h + k + l} \tan \text{D}.$$

132. To change the axes.

Let the new axes be the axes of the zones containing every two of the three faces hkk, khk, kkh. Then, u, v, w being the indices of a face when referred to the old axes, u', v', w' its indices when referred to the new axes,

$$u' = (h + k)u - kv - kw,$$

$$v' = -ku + (h + k)v - kw,$$

$$w' = -ku - kv + (h + k)w.$$

133. To determine the figure and angles of the form hkl, when h, k, l take particular values.

The angle between normals to any two faces of the same form may be computed by the formulæ in (124), (125), (126), and will be denoted by the letter placed upon the corresponding edge of the accompanying figure. The arrangement of the poles, when the three indices are unequal, is shown in fig. 43. The poles of the form hkk lie in zone-circles through the poles of the form 111, and those of the form $2\bar{1}\bar{1}$. The number of faces is given in (112).

134. The form 111 has two parallel faces.

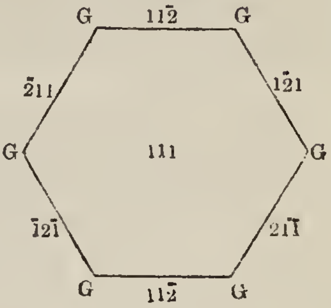
135. The forms $\kappa 111$, $\kappa\bar{1}\bar{1}\bar{1}$ consist of the faces 111, $\bar{1}\bar{1}\bar{1}$ respectively.

136. The form $\bar{2}11$ (fig. 45) is a regular six-sided prism.

$$G = 60^{\circ}.$$

137. The form $\kappa 2\bar{1}\bar{1}$ is bounded by three alternate faces of the form $\bar{2}11$, and $\kappa 2\bar{1}\bar{1}$ is bounded by the remaining three alternate faces.

FIG. 45.



138. The form $10\bar{1}$ (fig. 46) is a regular six-sided prism.

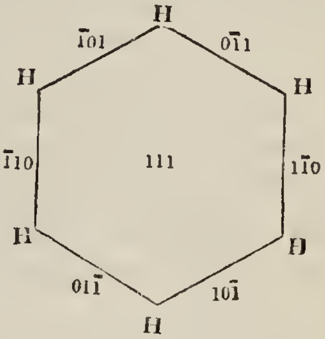
$$H = 60^{\circ}.$$

139. In a combination of the forms $10\bar{1}$, $\bar{2}11$, the faces of one form truncate the edges of the other.

$$11\bar{2}, 01\bar{1} = 30^{\circ}.$$

The faces of either of the forms $\kappa\bar{2}11$, $\kappa 2\bar{1}\bar{1}$ truncate the alternate edges of the form $10\bar{1}$.

FIG. 46.



In combinations of the form 111 with the forms $2\bar{1}\bar{1}$, $10\bar{1}$, the faces of $2\bar{1}\bar{1}$, $10\bar{1}$ make right angles with the faces of 111.

140. The form hkk is bounded by three pairs of parallel faces, making equal angles with each other. This form is called a rhombohedron.

Let T be the distance of any pole of the form hkk from the nearest pole of the form 111; V the distance between two adjacent poles equidistant from 111; W the distance between two adjacent poles not equally distant from 111, and D the distance of a pole of the form 100 from the nearest pole of the form 111. Then

$$\tan T = \frac{h-k}{h+2k} \tan D,$$

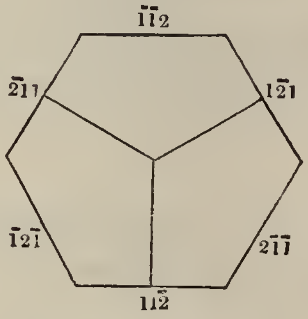
$$\sin \tfrac{1}{2} V = \sin 60^{\circ} \sin T,$$

$$W = 180^{\circ} - V.$$

The position of a rhombohedron is said to be direct when $\tan T$, $\tan D$ have the same signs, or when T, D are measured from 111 in the same direction, and inverse when $\tan T$, $\tan D$ have different signs, or when T, D are measured from 111 in different directions.

141. In combinations of rhombohedrons with the forms 111, $2\bar{1}\bar{1}$, the faces of a direct rhombohedron truncate the edges formed by 111 and each of the faces $2\bar{1}\bar{1}$, $\bar{1}2\bar{1}$, $\bar{1}\bar{1}2$; the faces of an inverse rhombohedron truncate the edges formed by 111 and each of the faces $\bar{2}11$, $1\bar{2}1$, $11\bar{2}$. The faces of the form 111 truncate the solid angle in which the edges V meet. A normal to 111 makes equal angles with normals to each of the three faces meeting in the edges V.

FIG. 47.



142. A normal to the faces of the form 111 is called the axis of the rhombohedron.

143. In a combination of the forms $2\bar{1}\bar{1}$, *hkk* (fig. 47), a normal to any face of the form *hkk* makes an angle 90° — T with a normal to the nearest face of the form $2\bar{1}\bar{1}$, and an angle U with a normal to either of the two next faces, where

$$\cos \mathrm{U} = \sin 30° \sin \mathrm{T}.$$

144. In a combination of the forms $10\bar{1}$, *hkk* (fig. 48), the faces of $10\bar{1}$ truncate the edges W of *hkk*.

The angles between normals to any face of the form *hkk* and normals to the three pairs of faces of the form $0\bar{1}1$, are $90° - \frac{1}{2}\mathrm{V}$, $90°$, $90° + \frac{1}{2}\mathrm{V}$.

145. The rhombohedron 100 (fig. 49), is direct.

$$100,111 = \mathrm{D}.$$

146. The rhombohedron 011 (fig. 50), is inverse.

$$\tan \mathrm{T} = -\tfrac{1}{2}\tan \mathrm{D}.$$

The faces of the form 011 truncate the edges V of the form 100.

FIG. 48.

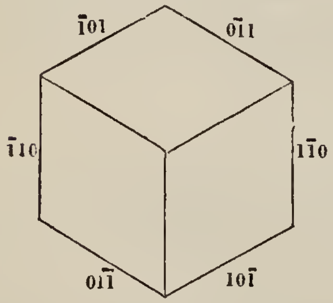


FIG. 49.

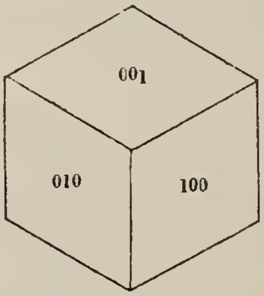
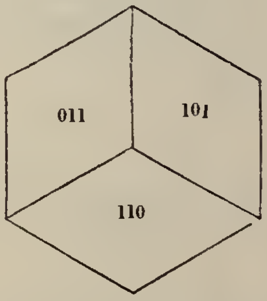


FIG. 50.



147. The rhombohedron 211 is direct. $\tan \mathrm{T} = \frac{1}{4}\tan \mathrm{D}$.

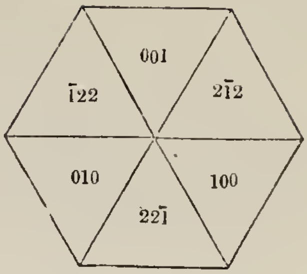
The faces of the form 211 truncate the edges V of the form 011.

148. The rhombohedron 311 is direct. $\tan \mathrm{T} = \frac{2}{5}\tan \mathrm{D}$.

149. The rhombohedron $\bar{1}22$ is inverse. $\tan \text{T} = - \tan \text{D}$.

Position excepted, the form of $\bar{1}22$ is the same as that of 100.

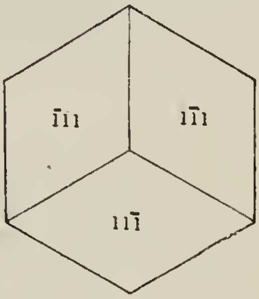
FIG. 51.



150. A combination of the forms 100, $\bar{1}22$ (fig. 51), is a double six-sided pyramid. The faces of the form $\bar{2}11$ truncate the edges which form the common base of the two pyramids.

$$\sin \tfrac{1}{2}(22\bar{1},100) = \sin 30^\circ \sin \text{D}.$$
$$1\bar{2}\bar{2},100 = 180^\circ - 2\text{D}.$$

FIG. 52.



151. The rhombohedron $\bar{1}11$ (fig. 52), is inverse. $\tan \text{T} = - 2 \tan \text{D}$.

The faces of the form 100 truncate the edges V of the form $\bar{1}11$.

152. The rhombohedron $3\bar{1}\bar{1}$ is direct. $\tan \text{T} = 4 \tan \text{D}$.

The faces of the form $\bar{1}11$ truncate the edges V of the form $3\bar{1}\bar{1}$.

153. The form κhkk has the three faces having the indices $+h$, $+k$, $+k$, which make equal angles with each other. The form $\kappa\bar{h}\bar{k}\bar{k}$ has the three faces with the indices $-h$, $-k$, $-k$.

154. Let P be the pole of one of the faces of a rhombohedron, the edges V of which are truncated by the face of another rhombohedron, the pole of which is S. Then $\tan \text{PO} = - 2 \tan \text{SO}$.

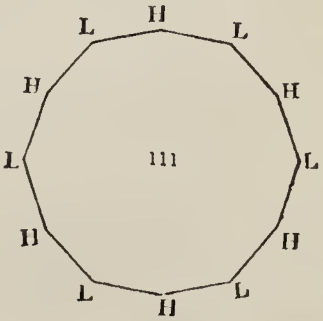
155. The form hkl, where $h + k + l = 0$ (fig. 53), has twelve faces in the same zone with the faces of the forms $0\bar{1}1$, $\bar{2}11$.

$$\tan \tfrac{1}{2}\text{H} = \sqrt{3}\,\frac{k - l}{2h - k - l},$$
$$\text{L} = 60^\circ - \text{H}.$$

The angles between a normal to any face and the adjacent faces of the forms $0\bar{1}1$, $\bar{2}11$, are $\tfrac{1}{2}\text{L}$, $\tfrac{1}{2}\text{H}$ respectively.

In the form $21\bar{3}$, H = 21° 47′.
In the form $31\bar{4}$, H = 32° 12′.
In the form $41\bar{5}$, H = 38° 13′.
In the form $32\bar{5}$, H = 13° 10′.
In the form $51\bar{6}$, H = 42° 6′.
In the form $52\bar{7}$, H = 27° 48′.
In the form $71\bar{8}$, H = 46° 50′.

FIG. 53.



In combinations of this form with the forms $01\bar{1}$, $\bar{2}11$, the faces of $01\bar{1}$ truncate the edges L, and the faces of $\bar{2}11$ truncate the edges H.

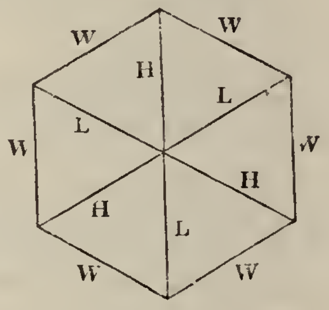
156. The form κhkl, where $h + k + l = 0$, is bounded by the alternate pairs of faces of the form hkl.

The angles between normals to adjacent faces are alternately H and $120^\circ - \mathrm{H}$.

157. The form πhkl, bounded by the alternate faces of the form hkl, is a regular six-sided prism.

158. The form hkl has twelve faces. Let h, l be algebraically the greatest and least of the three indices; T, D the distances of any poles of the forms hkl, 100 from the nearest poles of the form 111;

FIG. 54.



$$\tan\theta = \sqrt{3}\,\frac{k - l}{2h - k - l},$$

$$\tan\phi = \sqrt{3}\,\frac{l - h}{2k - l - h},$$

$$\tan\psi = \sqrt{3}\,\frac{h - k}{2l - h - k},$$

$$\tan\mathrm{T} = \frac{\sqrt{\{\tfrac{1}{2}[(k - l)^2 + (l - h)^2 + (h - k)^2]\}}}{h + k + l}\tan\mathrm{D}.$$

$$\sin\tfrac{1}{2}\mathrm{H} = \sin\theta\sin\mathrm{T}, \quad \sin\tfrac{1}{2}\mathrm{K} = \sin\phi\sin\mathrm{T},$$
$$\sin\tfrac{1}{2}\mathrm{L} = \sin\psi\sin\mathrm{T}, \quad \mathrm{W} = 180^\circ - \mathrm{K}.$$

When the algebraic sum of two of the indices is equal to twice the third, H and L are equal.

159. In a combination of the forms hkl, $10\bar{1}$, the faces of $10\bar{1}$ truncate the edges W of hkl.

The angle between normals to any face of the form hkl, and the nearest face of the form $10\bar{1}$, is $90^\circ - \tfrac{1}{2}\mathrm{K}$.

In a combination of the forms hkl, $\bar{2}11$, the faces of $\bar{2}11$ truncate the solid angles of hkl, in which the edges W, H, L meet.

160. Each of the forms κhkl, $\kappa\bar{h}\bar{k}\bar{l}$, has the faces of one of the two pyramids which, joined base to base, constitute the form hkl.

161. Each of the forms πhkl, πlkh, is bounded by the alternate faces of the form hkl, which occur in three parallel pairs, making equal angles with each other. Let V, W be the dis-

tances between two adjacent poles equally and unequally distant from the pole 111. Then

$$\sin\tfrac{1}{2}\mathrm{V} = \sin 60^\circ \sin \mathrm{T}, \quad \mathrm{W} = 180^\circ - \mathrm{V}.$$

162. In the forms αhkl, αlkh, let V be the distance between adjacent poles equally distant from the pole 111; U, W the distances between adjacent poles unequally distant from the pole 111. Then

$$\sin\tfrac{1}{2}\mathrm{V} = \sin 60^\circ \sin \mathrm{T}, \quad \mathrm{U} = 180^\circ - \mathrm{H}, \quad \mathrm{W} = 180^\circ - \mathrm{K}.$$

163. The cleavages, in crystals belonging to the rhombohedral system, are parallel to the faces of the forms $01\bar{1}$, 111, or to those of forms which have two of their indices equal.

PRISMATIC SYSTEM.

164. In the prismatic system the axes make right angles with each other.

165. The form hkl is bounded by all the faces having for their symbols the different combinations of $\pm h$, $\pm k$, $\pm l$, each index having always the same place. When h, k, l are all finite, the form hkl will have the eight faces.

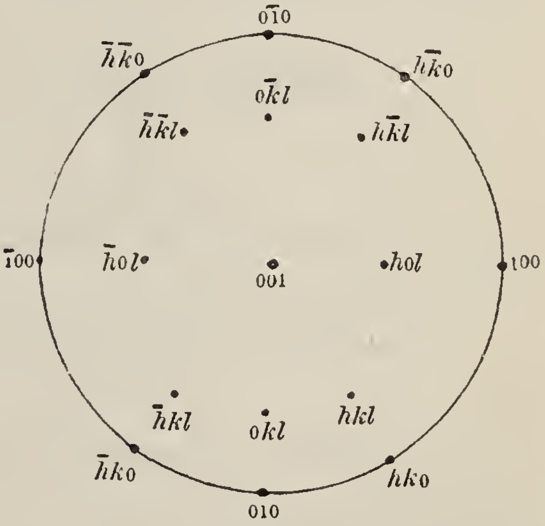
$$\begin{array}{cccc} h\,k\,l & h\,\bar{k}\,\bar{l} & \bar{h}\,k\,\bar{l} & \bar{h}\,\bar{k}\,l \\ \bar{h}\,\bar{k}\,\bar{l} & \bar{h}\,k\,l & h\,\bar{k}\,l & h\,k\,\bar{l} \end{array}$$

When one of the indices is zero, the number of faces will be four. When two of the indices are zero, the number of faces will be two.

166. The arrangement of the poles of hkl on the surface of the sphere of projection is shown in the annexed figure.

167. The form bounded by all the faces of hkl, which have either an odd number of positive indices, or an odd number of negative indices, is said to be hemihedral with inclined faces, and will be denoted by κhkl, where hkl is the symbol of any one of its faces.

FIG. 55.



The symbols of the faces of κhkl are contained in the upper line, those of $\kappa\bar{h}\bar{k}\bar{l}$ in the lower line of the above table.

The form κhkl consists of four alternate faces of the form hkl, $\kappa\bar{h}\bar{k}\bar{l}$ of the other four alternate faces.

168. The form bounded by all the faces of hkl, in the symbols of which the sign of one of the indices remains unchanged, is said to be hemihedral with symmetric faces, and may be denoted by the symbol ςhkl, the index which preserves its sign unchanged, having its proper sign placed over it.

The poles of the two half forms will be found respectively in the two hemispheres into which the surface of the sphere is divided by a zone-circle through two of the three poles 100, 010, 001.

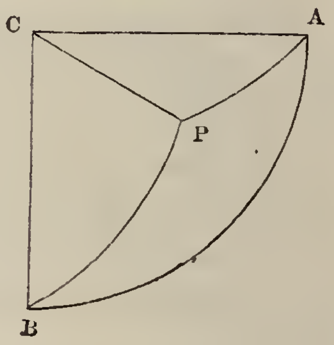
169. The form bounded by all the faces of the form hkl, in which two of the indices change their signs together, is said to be hemihedral with parallel faces, and may be denoted by the symbol πhkl, a dot being placed over that index, the sign of which is independent of the signs of the other two indices.

The poles of the half form are found in two alternate lunes, of the four into which the sphere of projection is divided by two of the zone-circles through every two of the poles 100, 010, 001.

170. To determine the position of any pole.

Let A, B, C be the poles of the faces 100, 010, 001. 011,010 = D, 101,001 = E, 110,100 = F. D, E, F are connected by the equation $\tan \mathrm{D} \tan \mathrm{E} \tan \mathrm{F} = 1$. P the pole of hkl. BC, CA, AB are quadrants.

FIG. 56.



$$\tan \mathrm{PAB} = \frac{l}{k} \tan \mathrm{D},$$

$$\tan \mathrm{PBC} = \frac{h}{l} \tan \mathrm{E},$$

$$\tan \mathrm{PCA} = \frac{k}{h} \tan \mathrm{F}.$$

$$\cot \mathrm{PA} = \frac{h}{k} \cot \mathrm{F} \cos \mathrm{PAB} = \frac{h}{l} \tan \mathrm{E} \cos \mathrm{PAC},$$

$$\cot \mathrm{PB} = \frac{k}{l} \cot \mathrm{D} \cos \mathrm{PBC} = \frac{k}{h} \tan \mathrm{F} \cos \mathrm{PBA},$$

$$\cot \mathrm{PC} = \frac{l}{h} \cot \mathrm{E} \cos \mathrm{PCA} = \frac{l}{k} \tan \mathrm{D} \cos \mathrm{PCB}.$$

Any two of the three angles D, E, F are the angular elements of a crystal belonging to the prismatic system.

171. The poles of the form hkl are symmetrically situated with respect to each of the zone-circles through every two of the poles 100, 010, 001.

The poles of the two halves of the same holohedral form may, in every case, be made to change places with each other, by causing the sphere of projection to revolve through two right angles round the poles of one of the forms 100, 010, 001.

172. In the form 0kl, if L be the distance between two poles differing only in the sign of l,

$$\tan\tfrac{1}{2}\text{L} = \frac{l}{k}\tan\text{D}.$$

173. In the form h0l, if H be the distance between the poles differing only in the sign of h,

$$\tan\tfrac{1}{2}\text{H} = \frac{h}{l}\tan\text{E}.$$

174. In the form hk0, if K be the distance between two poles differing only in the sign of k,

$$\tan\tfrac{1}{2}\text{K} = \frac{k}{h}\tan\text{F}.$$

175. In the form hkl, if H, K, L be the distances between any two poles, the symbols of which differ only in the signs of h, k, l respectively,

$$\tan\phi = \frac{k}{h}\tan\text{F},\quad \tan\tfrac{1}{2}\text{L} = \frac{l}{h}\cot\text{E}\cos\phi,$$

$$\sin\tfrac{1}{2}\text{K} = \cos\tfrac{1}{2}\text{L}\sin\phi,\quad \sin\tfrac{1}{2}\text{H} = \cos\tfrac{1}{2}\text{L}\cos\phi.$$

176. Let A, B, C be the poles of 100, 010, 001 respectively; P the pole of hkl, Q that of pqr.

Let Q be in the zone-circle PA. Then

$$\frac{\tan\text{PA}}{\tan\text{QA}} = \frac{pk}{hq} = \frac{pl}{hr}.$$

Let Q be in the zone-circle PB. Then

$$\frac{\tan\text{PB}}{\tan\text{QB}} = \frac{ql}{kr} = \frac{qh}{kp}.$$

Let Q be in the zone-circle PC. Then

$$\frac{\tan\text{PC}}{\tan\text{QC}} = \frac{lh}{rp} = \frac{lk}{rq}.$$

177. To find the distance between any two poles.

Let P, Q be the poles of hkl, pqr; A, B, C the poles of 100, 010, 001. Let PQ meet the zone-circle AB in M. Then, the tangents of MCA, PCA, QCA can be found in terms of h, k, l, p, q, r, and two of the three angles D, E, F; therefore PCM, QCM are known.

PC can be found in terms of h, k, l, and two of the three angles D, E, F.

$$\cos \text{PM} = \sin \text{PC} \cos \text{PCM},$$

$$\frac{\tan \text{QM}}{\tan \text{PM}} = \frac{\tan \text{QCM}}{\tan \text{PCM}}.$$

Therefore, PM, QM being known, PQ, which is their sum or difference, is known.

178. If the distance between any two poles of either of the forms $0kl$, $h0l$, $hk0$ be given, the indices may be obtained from the expressions in (172), (173), (174).

179. In the form hkl, the distances between any pole and each of two others, or their supplements, will be two of the arcs H, K, L; therefore two of the arcs H, K, L being known, ϕ, and thence h, k, l may be found from (175).

180. The angles D, E, F may be found from the expressions in (172), (173), (174), having given the distances between the poles of two of the forms $0kl$, $h0l$, $hk0$; or from the expressions in (175), having given the distance between any pole of the form hkl, and each of two others not all in the same zone-circle.

181. The angles D, E, F may also be found from the distances between three given poles in one zone-circle not passing through either of the poles 100, 010, 001.

Let P, Q, R be the three given poles; A, B, C the poles of 100, 010, 001. Let PR meet BC, CA, AB in L, M, N respectively. Then, knowing the symbols of P, Q, R, the symbols of L, M, N may be found by (19), (20). Therefore PL, PM, PN may be found by (22) or (24). Therefore the distances between L, M, N are known.

$$(\tan \text{LB})^2 = \frac{\tan \text{NL}}{\tan \text{LM}}, \quad (\tan \text{MC})^2 = \frac{\tan \text{LM}}{\tan \text{MN}}, \quad (\tan \text{NA})^2 = \frac{\tan \text{MN}}{\tan \text{NL}}.$$

The numerical values of tan MN, tan NL, tan LM being taken with positive signs.

Hence, knowing tan LB, tan MC, tan NA, and the symbols of L, M, N, the angles D, E, F may be found by (172), (173), (174).

182. To determine the figure and angles of the form hkl, when h, k, l take particular values.

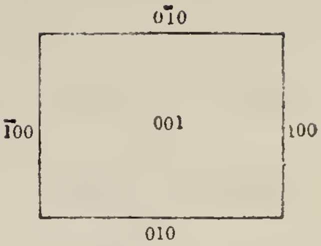
The angle between normals to any two faces is obtained from the expressions in (172) . . . (175), and will be denoted by the letter which, in the accompanying figure, is placed upon the edge formed by their intersection. The arrangement of the poles is shown in fig. 55. The number of faces is given in (165).

183. The three forms 100, 010, 001, have each two parallel faces.

In combinations of these forms with each other, the faces of any one form are perpendicular to those of each of the other two.

Either of the above forms may become hemihedral.

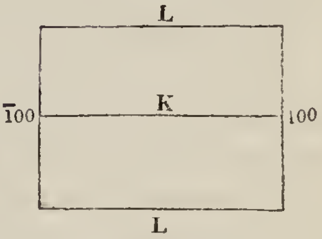
FIG. 57.



184. The form 0*kl* (fig. 58) has two pairs of parallel faces.

$$\tan\tfrac{1}{2}\mathrm{L} = \frac{l}{k}\tan\mathrm{D}, \quad \mathrm{K} = 180^\circ - \mathrm{L}.$$

FIG. 58.

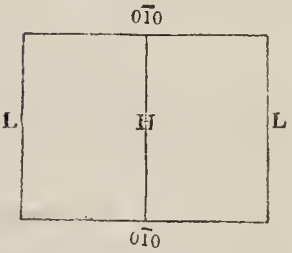


185. In a combination of the form 0*kl* with the forms 100, 010, 001, the faces of 100 are perpendicular to those of 0*kl*; and the faces of 010, 001 truncate the edges L, K respectively. A normal to any face of 0*kl* makes angles $\frac{1}{2}$L, $\frac{1}{2}$K with normals to the nearest faces of 010, 001 respectively.

186. The form *h*0*l* (fig. 59) has two pairs of parallel faces.

$$\tan\tfrac{1}{2}\mathrm{H} = \frac{h}{l}\tan\mathrm{E}, \quad \mathrm{L} = 180^\circ - \mathrm{H}.$$

FIG. 59.



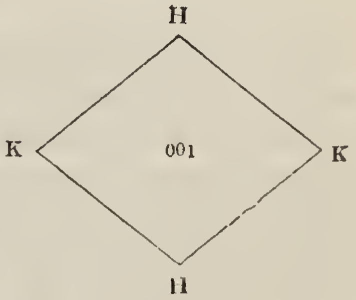
187. In combinations of the form *h*0*l* with the forms 100, 010, 001, the faces of 010 are perpendicular to those of *h*0*l*; and the faces of 001, 100 truncate the edges H, L respectively.

A normal to any face makes angles $\frac{1}{2}$H, $\frac{1}{2}$L with normals to the nearest faces of the forms 001, 100 respectively.

188. The form *hk*0 (fig. 60) has two pairs of parallel faces.

$$\tan\tfrac{1}{2}\mathrm{K} = \frac{k}{h}\tan\mathrm{F}, \quad \mathrm{H} = 180^\circ - \mathrm{K}.$$

FIG. 60.



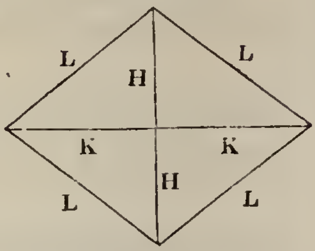
189. In combinations of the form *hk*0 with the forms 100, 010, 001, the faces of 001 are perpendicular to those of *hk*0; and the faces of 100, 010 truncate the edges K, H respectively.

A normal to any face of *hk*0 makes angles $\frac{1}{2}$K, $\frac{1}{2}$H with normals to the nearest faces of 100, 010 respectively.

190. When either of the forms 0*kl*, *h*0*l*, *hk*0 becomes hemihedral with symmetric faces, the half form consists of two adjacent faces.

When either of the above forms becomes hemihedral with parallel faces, the half form consists of two opposite faces.

FIG. 61.



191. The form hkl (fig. 61) has eight faces.

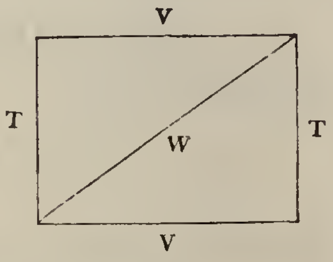
$$\tan\phi = \frac{k}{h}\tan\text{F},\quad \tan\tfrac{1}{2}\text{L} = \frac{l}{h}\cot\text{E}\cos\phi,$$

$$\sin\tfrac{1}{2}\text{K} = \cos\tfrac{1}{2}\text{L}\sin\phi,\quad \sin\tfrac{1}{2}\text{H} = \cos\tfrac{1}{2}\text{L}\cos\phi.$$

192. In a combination of the form hkl with the forms 100, 010, 001, the faces of 100 truncate the solid angles in which the edges K, L meet; the faces of 010 truncate the solid angles in which the edges L, H meet; and the faces of 001 truncate the solid angles in which the edges H, K meet.

A normal to any face of hkl makes angles $90° - \tfrac{1}{2}\text{H}$, $90° - \tfrac{1}{2}\text{K}$, $90° - \tfrac{1}{2}\text{L}$ with normals to the nearest faces of the forms 100, 010, 001 respectively.

FIG. 62.



193. The forms κhkl, $\kappa\bar{h}\bar{k}\bar{l}$ are irregular tetrahedrons, bounded by the alternate faces of the form hkl.

$\text{T} = 180° - \text{H}$, $\text{V} = 180° - \text{K}$, $\text{W} = 180° - \text{L}$.

194. In combinations of either of the above forms with the forms 100, 010, 001, the faces of 100, 010, 001 truncate the edges T, V, W respectively.

195. A hemihedral form with symmetric faces consists of four faces, which make one of the solid angles of fig. 61.

196. A hemihedral form with parallel faces has any two pairs of parallel faces of fig. 61.

OBLIQUE SYSTEM.

197. In the oblique system, one axis, OY, is perpendicular to each of the other two axes.

198. The form hkl is bounded by all the faces which have for their symbols the different combinations of $\pm h$, $\pm k$, $\pm l$, in which each of the three indices has always the same place, and the first and third indices change their signs together. When k is finite the form has the four faces,

$$h\,k\,l \qquad \bar{h}\,k\,\bar{l} \qquad h\,\bar{k}\,l \qquad \bar{h}\,\bar{k}\,\bar{l}.$$

When k is zero, or when each of the other two indices are zero, the number of faces will be two.

199. The hemihedral form, which we shall denote by σhkl,

where hkl is the symbol of one of its faces, is bounded by the faces of the form hkl in the symbols of which k has the same sign.

The poles of the two half-forms lie on different sides of the zone-circle 100,001.

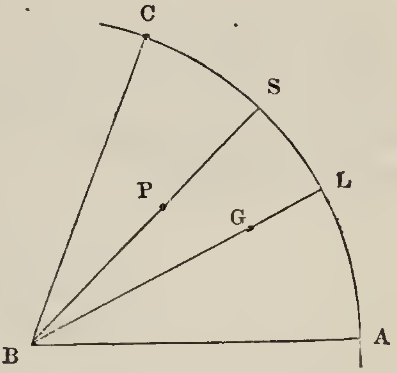
200. To determine the position of any pole.

Let A, B, C be the poles of 100, 010, 001; G, L the poles of 111, 101, the arcs AL, GB, LC being known; P the pole of hkl.

Let PB meet AC in S. AB, BC are quadrants.

The arc AS, which measures the angle PBA, is given by the equations

FIG. 63.



$$\tan\theta = \frac{h}{l}\frac{\sin \text{LC}}{\sin \text{AL}},$$

$$\tan(\text{AS} - \tfrac{1}{2}\text{AC}) = \tan\tfrac{1}{2}\text{AC}\tan(45^\circ - \theta),$$

$$\text{or } l(\cot \text{AS} - \cot \text{AC}) = h(\cot \text{AL} - \cot \text{AC}),$$

$$\tan \text{PB} = \frac{l}{k}\frac{\sin \text{AL}}{\sin \text{AS}}\tan \text{GB},$$

$$\cos \text{PA} = \sin \text{PB} \cos \text{AS}, \quad \cos \text{PC} = \sin \text{PB} \cos \text{CS}.$$

LA, GB, LC are the angular elements of a crystal belonging to the oblique system.

201. The poles of the form hkl are symmetrically arranged with respect to the zone-circle 001,100. In other words, they are in the zone-circle containing the poles of the form 010, and are equidistant from the nearest pole of 010.

202. Let P, Q be the poles of hkl, pqr, in a zone-circle passing through B, the pole of 010. Then

$$\frac{\tan \text{PB}}{\tan \text{QB}} = \frac{ql}{kr} = \frac{qh}{kp}.$$

203. To find the distance between any two poles.

Let P, Q be the poles of hkl, pqr; A, B, C the poles of 100, 010, 001; L the pole of 101. Let PQ meet CA in M. Then the symbol of M may be found by (19), (20), and MBA, PBA, QBA, PB may be found in terms of h, k, l, p, q, r, AL, LC, by (200).

PBM, QBM being known, we have

$$\cos \text{PM} = \cos \text{PBM} \sin \text{PB}.$$

$$\frac{\tan \text{QM}}{\tan \text{PM}} = \frac{\tan \text{QBM}}{\tan \text{PBM}}.$$

Whence PM, QM being known, PQ is known.

204. Let A, B, C (fig. 63) be the poles of 100, 010, 001; G, L the poles of 111, 101. Then, if S be the pole of any face *h*0*l* in the zone AC, knowing the distance AS, the indices *h*, *l* are given by the equation

$$\frac{h}{l} = \frac{\sin \mathrm{AL}}{\sin \mathrm{LC}} \frac{\sin(\mathrm{AC} - \mathrm{AS})}{\sin \mathrm{AS}}.$$

205. Let P (fig. 63) be the pole of any face *hkl*; S the intersection of BP, AC; knowing any two of the three arcs PA, PB, PC, the arcs PB, AS may be found; and the indices *h*, *k*, *l* are given by the equations

$$\frac{h}{l} = \frac{\sin \mathrm{AL}}{\sin \mathrm{LC}} \frac{\sin(\mathrm{AC} - \mathrm{AS})}{\sin \mathrm{AS}},$$

$$\frac{k}{l} = \frac{\sin \mathrm{AL}}{\sin \mathrm{AS}} \frac{\tan \mathrm{GB}}{\tan \mathrm{PB}}.$$

206. A, B, C (fig. 63) are the poles of 100, 010, 001; G, L the poles of 111, 101; P the pole of *hkl*. Having given PA, PB, PC, to find AL, GB, LC, the angular elements of the crystal.

Let PB meet AC in S.

$$\cos \mathrm{PC} = \sin \mathrm{PB} \cos \mathrm{SC}, \quad \cos \mathrm{PA} = \sin \mathrm{PB} \cos \mathrm{AS}, \quad \mathrm{AC} = \mathrm{AS} + \mathrm{SC}.$$

AS, SC, AC being known, AL is given by the equations

$$\tan\theta = \frac{l}{h}\frac{\sin \mathrm{SC}}{\sin \mathrm{AS}}, \quad \tan(\mathrm{AL} - \tfrac{1}{2}\mathrm{AC}) = \tan\tfrac{1}{2}\mathrm{AC}\,\tan(45^\circ - \theta),$$

$$\text{or} \quad h \cot \mathrm{AL} = l \cot \mathrm{AS} + (h - l) \cot \mathrm{AC}.$$

$$\tan \mathrm{GB} = \frac{k}{l}\frac{\sin \mathrm{AS}}{\sin \mathrm{AL}} \tan \mathrm{PB}.$$

207. A, B, C are the poles of 100, 010, 001, P, Q, R three poles in CA; T any pole not in CA. Having given PQ, QR, TB, and the symbols of P, Q, R, T, to find the angular elements of the crystal.

Let TB meet CA in S. The symbol of S may be found by (19), (20), PC, PA, PS may be found by (22) or (24). SA, TB, SC being known, the angular elements may be found as in (206).

FIG. 64.

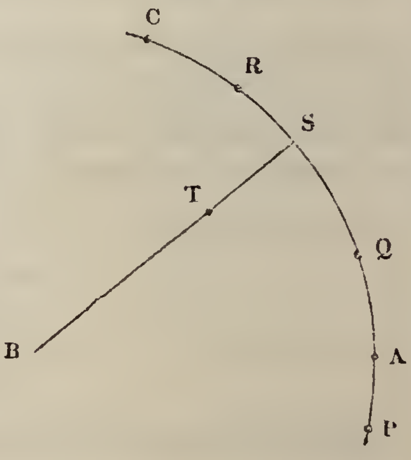
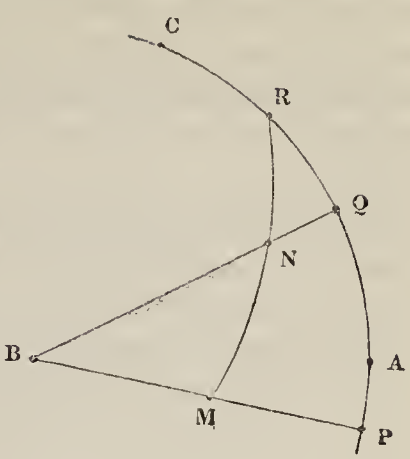


FIG. 65.



208. A, B, C are the poles of 100, 010, 001; M, N any two poles of different forms not in the zone-circle 001,100.

Having given MB, NB, MN, and the symbols of M, N, to find the angular elements of the crystal.

Let MB, NB, MN meet CA in P, Q, R, the symbols of M, N being known, those of P, Q, R are known. MB, NB, MN being known, PQ may be found.

$$\frac{\tan\frac{1}{2}(\mathrm{PR} - \mathrm{QR})}{\tan\frac{1}{2}(\mathrm{PR} + \mathrm{QR})} = \frac{\sin(\mathrm{NB} - \mathrm{MB})}{\sin(\mathrm{NB} + \mathrm{MB})},$$

which gives PR, QR. Whence AP, CP may be found by (22) or (24). From QA, NB, QC, or PA, MB, PC, the angular elements may be found by (206).

209. To change the axes.

Let u, v, w be the indices of any face, u', v', w' its indices when referred to the axes of the zones $p0r$,010, 001,100, $e0g$,010 as crystallographic axes; then

$$u' = pw - ru, \quad v' = v, \quad w' = gu - ew.$$

210. The form 010 has two parallel faces.

211. The form $h0l$ has two faces parallel to each other.

212. In a combination of the forms $h0l$, 010, the faces of $h0l$ are perpendicular to the faces of 010.

213. The form hkl has four faces, in two parallel pairs, forming a zone.

214. In a combination of the forms hkl, 010, normals to any face of hkl and the adjacent face of 010 make with each other an angle, which is measured by the arc PB, where PB has the value assigned to it in (200). The faces of the form 010 are in the same zone with those of hkl.

215. The hemihedral form σhkl has the two faces of the form hkl, adjacent to one of the faces of the form 010.

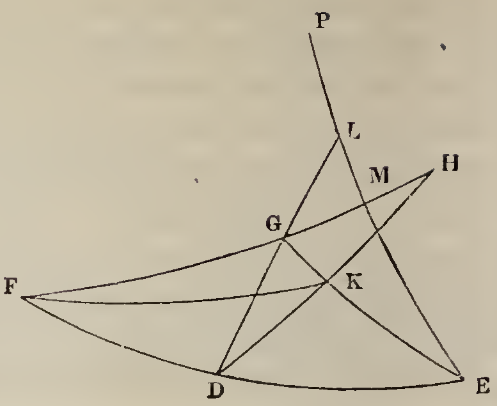
ANORTHIC SYSTEM.

216. In the anorthic system, the form hkl has the two faces hkl, $\bar{h}\bar{k}\bar{l}$.

217. To find the position of any pole.

D, E, G, H are any four poles, of which no three are in one zone-circle; F the intersection of the zone-circles ED, GH.

FIG. 66.



Having given the symbols of D, E, G, H, the arcs DF, EF, GF, HF, one of the arcs HD, HE, DG, EG, and the symbol of the pole P; to find the place of P.

Let the zone-circle through P and E intersect DG, HF in L, M. The symbols of D, G, H, E, P being known, the symbols of L, M, F may be found by (19), (20). The symbols of H, G, F, and the arcs FG, FH being known, FM may be found by (22) or (24). Compute EFM, GDF, MEF, EM, EL by the rules of spherical trigonometry. The symbols of E, M, L, P, and the arcs EM, EL being known, EP may be found by (22) or (24). EP and PEF being known, the position of P is fully determined.

When P is in either of the zone-circles FE, FH, its distance from F can be found at once by (22) or (24).

The four arcs FD, FE, FG, FH, and one of the arcs HD, HE, DG, EG may be taken for the angular elements of the crystal.

218. Having given the symbols of four poles D, F, G, K (fig. 66), any five of the arcs DF, FG, GK, KD, GD, KF, and the symbol of the pole P; to find the position of P.

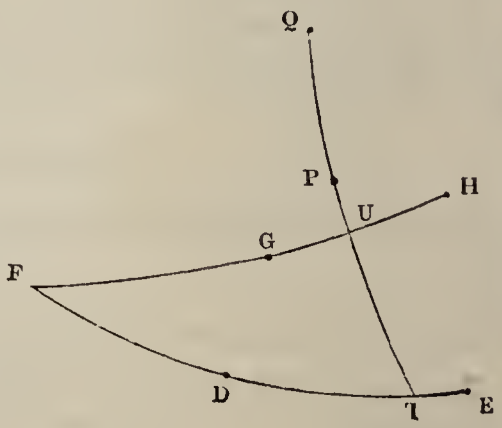
Let E be the intersection of KG, DF; H the intersection of DK, FG. The symbols of F, G, K, D being known, those of E, H may be found by (19), (20).

Compute FE, FH by the methods of spherical trigonometry. Then, the symbols of F, G, H, D, E being known, and the arcs FG, FH, FD, FE, DG, the position of P may be found by (217).

Any five of the six arcs DF, FG, GK, KD, DG, KF can be used as angular elements, but not so conveniently as the angular elements adopted in the preceding article.

219. To find the distance between any two poles.

FIG. 67.



Let F, G, H, D, E have the same signification as in (217); let P, Q, be the two poles, and let PQ intersect FE, FH in T, U, and one of the circles GD, GE, DH, EH in V.

The symbols of T, U, V may be found by (19), (20). The symbols of F, D, E, G, H, T, U, and the arcs FD, FE, FG, FH being known, FT, FU may be found by (22) or (24). UT, VT may be found by the rules of spherical trigonometry. UT, VT, and the symbols of T, U, V, P, Q being known, TP, TQ may be found by (22) or (24).

If the arcs PE, QE, and the angles PEF, QEF have been found by (217) or (218), PQ may be computed from PE, QE and QEP by the rules of spherical trigonometry.

All the poles are usually so situated in the intersections of zone-circles, that their places, and their distances from each other, may be readily found by (19), (20), and (22) or (24), and the ordinary rules of spherical trigonometry, without having recourse to the methods above given.

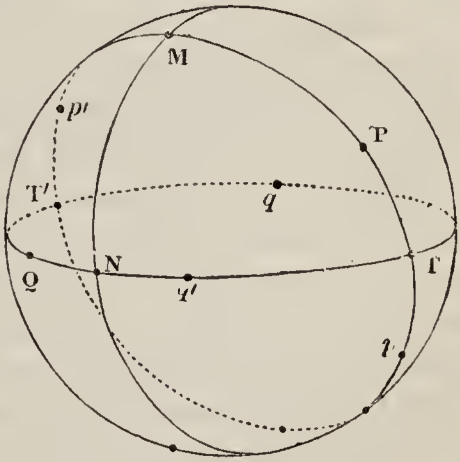
TWIN CRYSTALS.

220. A twin crystal is composed of two crystals joined together in such a manner that one would come into the position of the other, by revolving through two right angles round an axis perpendicular to a plane, which either is, or may be, a face of either crystal. The axis will be called the twin axis, and the plane to which it is perpendicular the twin plane.

The faces of the two crystals are symmetrical with respect to a plane parallel to the twin face.

221. In order to find the twin axis in any given twin crystal, when it cannot be done by simple inspection, we must determine by measurement, or by the observation of zones, the intersection of two great circles, each of which passes through the poles of corresponding or opposite faces of the two crystals. If the intersections of the circles be the poles of corresponding faces of the two crystals, they will be the poles of a twin plane.

FIG. 68.



Let P, Q be the poles of any two faces of one crystal; p, q the poles of the corresponding faces of the other, p', q' the poles of the faces opposite to p, q; T, T′ the intersections of the great circles pPp', qQq'. Then T, T′ are the poles of the twin plane.

222. Crystals belonging to the anorthic system are sometimes united in such a manner that one would come into the position of the other by revolving through two right angles round the axis of a zone.

223. When the twin plane, and the angles between the faces of one of the crystals are given, the angle between any faces of each of the two crystals can be readily determined.

Let P, p (fig. 68) be the poles of corresponding faces of the two crystals, p' the pole opposite to p. Then $PT = p'T'$, therefore $Pp' = 180° - 2PT$. When PT is greater than 90°, the faces P, p' will form a re-entering angle. Next let P, q' be any poles of each of the two crystals, q, q' opposite poles of the same crystal; Q the pole of one crystal corresponding to the pole q of the other. PT, QT, PQ give PTQ. $Tq' = 180° - TQ$. PT, Tq', PTQ being known, Pq' may be found.

GONIOMETERS.

224. Carangeot's Goniometer consists of two small metal rulers (fig. 69), fastened together by a pin so as to move stiffly on each other. In order to measure the mutual inclination of two faces of a crystal, the rulers are placed with their edges touching the faces of the crystal in lines perpendicular to the intersection of the faces. The rulers are then applied to a graduated semi-circle (fig. 70), without altering their position with respect to each other, so that the intersection of their edges may coincide with the centre of the graduation. The portion of the graduated arc, contained between the edges of the rulers, will then measure the supplement of the inclination of the planes, or of the distance between their poles. This instrument is obviously incapable of affording accurate results.

FIG. 69.

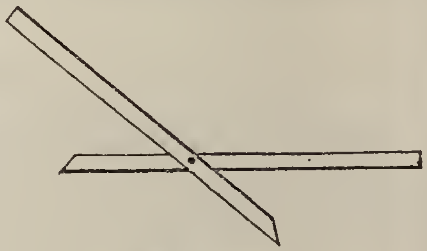
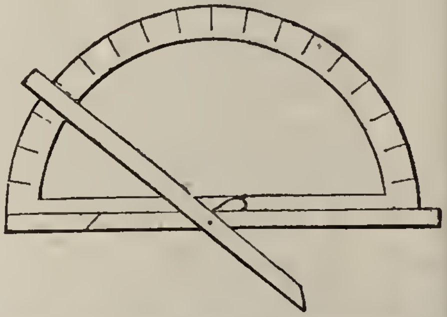


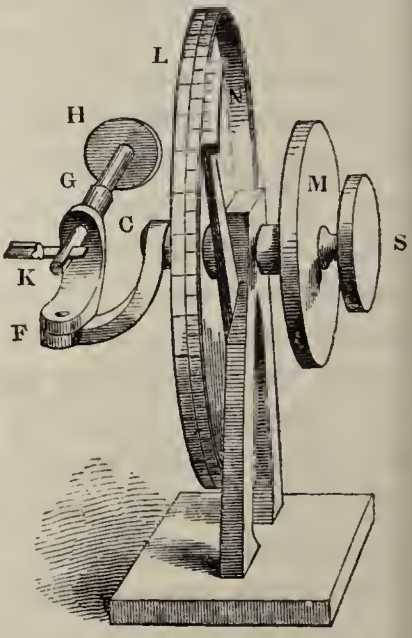
FIG. 70.



225. The Reflective Goniometer of Wollaston.

A graduated circle L, the divisions of which may be read off to minutes, by means of a vernier N, is fixed on a hollow axle which may be turned round by the milled head M. An axle CS passing through the hollow axle of L, and which either turns with the circle L, or may be turned independently, by means of the milled head at S, carries a crooked arm GF. The part FG is connected with CF by a joint which permits it to turn round an axis perpendicular to CS, passing through CS produced, and has a collar at G in which the pin

FIG. 71.



HK turns and slides, with its axis perpendicular to the axis of FG, and passing through the point in which SC produced, intersects the axis of FG. The crystal is fastened by means of a soft cement to a thin plate of metal, fixed in a slit at K.

226. To measure the angle between two faces of a crystal.

Let *p*, *q* be two faces of a crystal. Make the intersection of *p*, *q* parallel to the axis of the circle, and as nearly coincident with it as possible, by means of the angular motion of FG, and the angular and sliding motion of HK. Place the instrument upon a firm stand, and let A, B be two signals in a plane passing through a point K in the intersection of the faces *p*, *q*, and perpendicular to the axis of the circle. Turn the circle till the image of one of the signals A, seen by reflexion in the face *p*, coincides with B viewed directly, and read off the arc at which zero of the vernier stands. Now turn the circle till the image of A, seen by reflexion in *q*, coincides with B, seen by direct vision, and read off the arc at which zero of the vernier stands. The difference of the two readings will measure the angle between the faces *p*, *q*.

227. If a face *r* belong to the zone of *p*, *q*, it will be parallel to the axis of the circle, and, therefore, in some one position of the circle, the image of A seen by reflexion in *r* will coincide with B seen directly. Hence, in order to find the faces which belong to the zone containing two given faces, we must adjust the crystal as for the purpose of measuring the angle between those faces, and then, while the circle makes one revolution, observe the faces that afford by reflexion images of A passing through B.

228. In order to make ABK, the plane through the two signals and the crystal, perpendicular to the axis of the circle, turn the stand of the instrument, or move A, till the image of A seen by reflexion in the plane surface of the circle, or in any bright plane surface fixed parallel to it, coincides with a point A′ seen directly, the distance of which from A, in a line parallel to the axis, is equal to twice the distance of the crystal from the plane of the circle, or from the reflecting surface. Let a solid having two bright parallel surfaces, be fixed in the place of the crystal, and adjusted till the image of A seen by reflexion in either surface, describes the same path while the circle revolves, and place the lower signal B in the path traced out by the image of A. Having thus made the plane ABK perpendicular to the axis of the instrument, the intersection of the faces *p*, *q* is known to be parallel to the axis, when, on turning the milled head S, the images of A, seen by reflexion in *p*, *q*, are observed to pass through B. The adjustment of the edge *p*, *q* is most easily made by cementing the crystal to the plate K, with one of the two faces, *p* for example, nearly parallel to the plate, which is to be fixed in the slit at the end of HK, so that intersection of

p, q may be nearly perpendicular to HK, and, therefore, HK nearly perpendicular to CS. By turning HK round its axis, the path of the image of A seen in p, may be made to pass through B; and then, by turning FG on its axle at F, the path of the image of A seen in q may be made to pass through B. Should the latter adjustment disturb the former, the process must be repeated.

229. The instrument, as it is usually constructed in this country, is encumbered with a spring stop, which allows the circle to be turned in one direction only, and serves to fix it, not very accurately, at 0° or 180°. This should be removed by taking out the screws which fasten it.

In using the instrument, it will be found most convenient to turn it in such a direction that the degrees increase in passing from one face to the next.

The distances of the two signals from the crystal should be nearly equal, and not less than six or eight feet. The more distant the better. The upper signal, when the observations are made in the day time, may be a narrow black bar, or a horizontal slit in a screen placed in the upper part of a window, parallel to the axis of the circle; and the lower signal, a white line on a black ground also parallel to the axis of the circle. In some cases an image of the sun, formed by a lens of short focal length, or a small round hole in a screen through which the light of the sky is seen, may be used with advantage for the upper signal. In observing at night two narrow slits in screens, through one of which is seen the flame of a candle, and through the other a sheet of paper illuminated by a candle placed behind it, answer extremely well for the upper and lower signals respectively.

The best bright signal is obtained by reflecting the light of the sun from a plane mirror, or heliostat, through a triangular opening in a plate of metal, which, by means of a slider, may be diminished or increased according as the faces of the crystal are more or less perfect. The faint signal may be a horizontal slit in a plate of metal, illuminated by a sheet of white paper placed behind it, viewed by reflexion in a mirror of black glass. The signals A, B may then be nearly on a level with the eye of the observer, and need not be more than six inches distant from each other. In observing, the image of A, seen by reflexion in a face of the crystal, is made to coincide with the image of B seen by reflexion in the mirror, which should make an angle of about 40° with a horizontal plane. When the mirror is attached to the foot of the goniometer, any unsteadiness in the support of the goniometer will not affect the accuracy of the observations.

It is not essential that the axis of the goniometer should be horizontal. A goniometer with a vertical axis, though perhaps not quite so convenient in use, is free from some sources of inaccuracy to which a goniometer with a horizontal axis is subject.

230. When the points of p, q, at which the reflexions take place, are not equally distant from the axis of the circle, the angle through which the circle revolves between the two observations will differ slightly from the angle between the faces p, q. This error may be eliminated, when the signals A, B are nearly equidistant from the crystal, by turning the instrument half round in azimuth, and repeating the observations. A mean of the two results will be free from the error arising from the eccentricity of the points at which the reflexions take place.

When either of the faces is large, it should be blackened over, except at the point where it is intended the reflexion should take place. Any error that may arise from imperfect centring of the circle, will be eliminated, if the observations be repeated so that observations at a given face be made with zero of the vernier at points of the graduated circle distant nearly 180° from each other.

231. In many crystals, not belonging to the cubic system, Mitscherlich discovered that the angles between certain faces, vary slightly with the temperature of the crystal; thus the directions of the cleavages of calcite, which, at the ordinary temperature of the atmosphere, make angles of 75° 55′ with each other, become more nearly right angled by 8′·5, when the temperature of the crystal is increased 100° C. For the same increase of temperature a line perpendicular to the face 111 expands 0·00286, and a line parallel to the face 111 contracts 0·00056 of its length. The distance between the poles of the faces m, m', of a crystal of aragonite, is diminished 2′·8, and the distance between the poles of the faces k, k' is increased 5′·5 by increasing the temperature of the crystal 100° C. In a crystal of gypsum, which belongs to the oblique system, the angle between the two axes, to which the third axis is perpendicular, and the ratios of the parameters, all vary with a change of temperature.

FIGURES OF CRYSTALS.

232. The drawing of a crystal is the projection, on a given plane, of the lines in which the faces of the crystal intersect each other. Hence, if lines be drawn parallel to the projections of the several edges, in the order in which they meet, the lines representing opposite edges being equidistant from the centre of the drawing, the figure of the crystal will be obtained.

When the inclination of the axes and the ratios of the parameters are known, the direction of the projection of the edge in which any two faces intersect, may be found in the following manner :—

Let OX, OY, OZ be the projections of the three axes, a, b, c the projections of the corresponding parameters, hkl, pqr the symbols of any two faces,

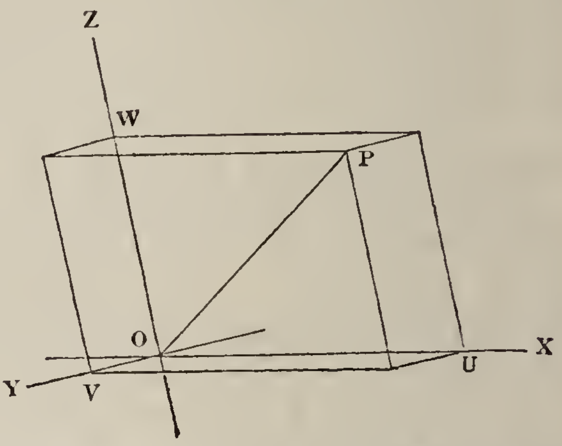
$$\mathrm{u} = kr - lq,\ \mathrm{v} = lp - hr,\ \mathrm{w} = hq - kp.$$

$$\mathrm{OU} = \frac{a}{\mathrm{u}},\ \mathrm{OV} = \frac{b}{\mathrm{v}},\ \mathrm{OW} = \frac{c}{\mathrm{w}},$$

OU, OV, OW being taken towards X, Y, Z, or in the opposite direction, according as u, v, w are positive or negative.

P the angle opposite to O of the figure of the parallelopiped having OU, OV, OW for its edges. Then, the projection of the edge in which the two faces meet, will be parallel to OP.

FIG. 72.



233. In this volume the figures of crystals of the cubic system are projections upon a plane parallel to the face 010, by parallel lines not perpendicular to that face. Draw ZOZ′, XOX′ intersecting at right angles in O; YOY′ so that the angle XOY′ may be about 20°. In OZ, OX take the points C, A equidistant from O; and in OY take OB equal to from one-third to one-fourth of OA. In OX, OY, OZ take OU, OV, OW equal to $\frac{1}{\mathrm{u}}$OA, $\frac{1}{\mathrm{v}}$OB, $\frac{1}{\mathrm{w}}$OC, towards X, Y, Z or towards X′, Y′, Z′, according as u, v, w are positive or negative. Then, the projection of the edge in which the faces meet, will be parallel to the line joining O and the opposite angle of the figure of the parallelopiped UVW.

H, H′, K, K′, L, L′ being the points in which XOX′, YOY′, ZOZ′ are intersected by the adjacent faces of any simple form, the pairs of distances OH, OH′, OK, OK′, OL, OL′ should be taken proportional to OA, OB, OC respectively.

The figures of crystals of the pyramidal system, are projections upon a plane parallel to the face 001, by lines perpendicular to that face. Draw XOX′, YOY′ intersecting at right angles in O. In OX, OY take A, B equidistant from O, and OU, OV equal to $\frac{1}{\mathrm{u}}$OA, $\frac{1}{\mathrm{v}}$OB, towards X, Y or towards X′, Y′, according as u, v are positive or negative. Then, the projection of the edge in which the faces intersect, will be parallel to the line joining O and the opposite angle of the parallelogram UV. The projections of the greater number of the edges are either parallel to the lines OX, OY, or make angles of 45° with them.

The figures of crystals of the rhombohedral system, are projections upon a plane parallel to the face 111, by lines perpendicular to that face. Draw three lines XOX′, YOY′, ZOZ′ intersecting in O so that each of the angles ZOX, XOY, YOZ may be 120°. In OX, OY, OZ take A, B, C equidistant from O, and OU, OV, OW equal to $\frac{1}{u}$OA, $\frac{1}{v}$OB, $\frac{1}{w}$OC, towards X, Y, Z or X′, Y′, Z′, according as u, v, w are positive or negative. Then, the projection of the edge in which the faces intersect, will be parallel to the line joining O and the opposite angle of either of the parallelograms VW, WU, UV. The projections of most of the edges are either parallel or perpendicular to OX, OY, OZ.

The figures of crystals of the prismatic system are projections upon a plane parallel to the face 001, by lines perpendicular to that face. Draw XOX′, YOY′ intersecting at right angles in O. Draw any line AB intersecting OX in A and OY in B, so that the angle BAO = 110,010. In OX, OY take OU, OV equal to $\frac{1}{u}$OA, $\frac{1}{v}$OB towards X, Y or towards X′, Y′, according as u, v are positive or negative. Then, the projection of the edge in which the faces meet, will be parallel to the line joining O and the opposite angle of the parallelogram UV.

The figures of crystals of the oblique system are projections upon a plane parallel to the face 010 by lines perpendicular to that face. Draw ZOZ′, XOX′ intersecting in O at an angle such that XOZ′ = 001,100. Draw any line CA intersecting OZ in C and OX in A, so that the angle ACO = 101,100, or CAO = 101,001. In OZ, OX take OW, OU equal to $\frac{1}{w}$OC, $\frac{1}{u}$OA towards Z, X or towards Z′, X′, according as w, v are positive or negative. Then, the projection of the edge in which the faces meet, will be parallel to the line joining O and the opposite angle of the parallelogram WU.

In the figures of crystals of the pyramidal, rhombohedral, prismatic and oblique systems, the intersections of the different faces of any one form with the nearest faces of any other form, should be drawn equally distant from the point O.

The figures of crystals of the anorthic system are projections upon a plane perpendicular to the axis of the zone 100,010, by lines parallel to the axis of that zone. Draw XOX′, YOY′ intersecting in O, at an angle such that XOY′ = 010,100. Draw any line AB intersecting OX and OY in A, B, so that ABO = 110,100, or BAO = 110,010. In OX, OY take OU, OV equal to $\frac{1}{u}$OA, $\frac{1}{v}$OB towards X, Y or towards X′, Y′, according as u, v are positive or negative. Then, the projection of the edge in which the faces intersect, will be parallel to the line joining O and the opposite angle of the parallelogram UV.

CLEAVAGE.

234. When a mineral is broken by a hammer, or otherwise

split, the fresh surfaces are either flat, or uneven in very different degrees.

The flat surfaces are referred to this head of cleavage, and the uneven ones to fracture.

Other faces parallel to the flat surfaces thus exposed may generally be discovered by splitting, or, as it is termed, cleaving the mineral in the corresponding directions.

The faces which may thus be developed by cleavage are of two kinds; one consisting of layers of thin crystals, which are separated at their surfaces, but which admit of no farther division or cleavage between such surfaces; the other consisting of planes which may be produced at indefinitely small distances from each other, and apparently belong to the structure of the mineral itself. The first of these kinds will be termed *faces of union*, and the second *cleavage planes.*

The faces of union are generally found in one direction only; but the cleavage planes usually occur in two or more directions, and frequently in such as to produce a crystalline solid; and if the mineral occurs in regular crystals, the cleavage planes will generally be parallel to some of their faces. When the specimen is sufficiently large, it may be rested on a small steel anvil, and be split with a small chisel and a light hammer; when less, a pair of pincers with parallel cutting edges may be used; and sometimes a knife may be sufficient to detect the cleavage planes in a small crystal, which, for this purpose, must be firmly held between the forefinger and thumb.

Cleavage planes assist in determining the crystalline form of the mineral under examination, and by which its species may frequently be known; they will also generally afford more exact angular measurements than can be obtained from the natural faces of the crystals.

The variety of pyroxene named sahlite affords an instance of faces of union, and galena and calcite examples of cleavage planes in three directions. We include under the head of cleavage the separation of the thin leaves of mica, sulphate of lime, and other minerals of similar structure.

STRUCTURE.

235. This term is used to express the manner in which the separate parts of minerals are aggregated together, as far as it can be ascertained by mechanical disruption of the mass.

The varieties of structure are

Crystalline, where the broken surfaces present the cleavage planes referred to in the preceding section.

Laminar, where the mass admits of easy separation into indefinitely thin plates in only one direction, as in mica.

The laminæ may be either flat or curved.

When the laminæ are so firmly held together as to allow of division only into plates of variable thickness, the structure is termed slaty.

These laminar and slaty structures also produce more or less perfect cleavage planes.

Fibrous, the fibres varying in size from those of the most delicate asbestus to large and rigid, in which condition the structure is said to be

Columnar; but as it passes by insensible degrees from fine to coarse, there is no apparent limit to either character, nor has any been assigned by which they may be distinguished.

The fibrous may be either straight or bent, and their relative positions may be parallel, divergent, radiating, promiscuous, or matted, which structure is generally the cause of toughness.

Granular, either large or small.

When the grains cohere slightly, the mineral is termed sandy, earthy, pulverulent, as chalk; where the cohesion is greater, the mineral is said to be compact.

The grains are sometimes small regularly-formed crystals, or crystalline masses, which, on breaking the specimen, may exhibit separately their own proper structure.

The structure is frequently alike in different minerals; and hence it ceases to be an exact determinative character.

FRACTURE.

236. This term is used to denote the uneven and irregular surfaces produced by breaking minerals. These are not, however, to be relied upon as distinctive characters; for different specimens of the same mineral will exhibit different forms of fracture, according to their more or less pure and perfect state, and, probably, according to the direction in which the fracture takes place.

The following are the kinds of fracture usually described:—

Conchoidal, as in flint.

Uneven.

Splintery, when the broken surface exhibits protruding points.

Hackly, as in some metals when broken.

The uneven and splintery fractures are common to so many minerals as to render those characters of comparatively little value in determining species.

INDETERMINATE FORMS.

237. The following are some of the irregular and accidental shapes of minerals, the varieties of which are too numerous to

allow of a specification of more than a few of the most prominent groups.

Amorphous, when no trace of crystallization can be perceived.

Nodular, when the external surfaces are natural and uneven, sometimes with protuberances and deep hollows.

Globular, when the nodules approach to spheres.

Mamillary, when the globules appear to be embedded, and only segments of spheres are seen above the surface of the mass.

Botryoidal, when the separate globules are more prominent and entire, and bear a rude resemblance to a bunch of grapes, adhering to each other by their surfaces.

Reniform, or kidney-shaped.

Amygdaloidal, or almond-shaped.

Stalactitic, when the surfaces are more or less cylindrical or conical. These may be solid or tubular.

Coralloidal, as in aragonite.

Wiry, as in native silver.

Capillary.

Fungiform, as iron pyrites from the chalk.

Dendritic,
Mossy,
Leafy, } as in native copper.

TRANSPARENCY.

238. This, from its being common in an equal degree to many different minerals, and frequently differing considerably in the same specimen, is of little practical value in mineralogy. In systematic descriptions, minerals are said to be

Transparent, when objects can be seen distinctly through them.

Semitransparent, when objects are indistinctly seen.

Translucent, when light can be perceived, but not objects.

Opaque, when they fail to transmit light.

LUSTRE.

239. The kind of lustre of a mineral is an important physical character, depending upon its refractive power and structure, and therefore permanent for the same mineral species, when in a state of purity. But as this so rarely occurs, and as each kind is common to many different minerals, it is, when taken alone, of limited use in the discrimination of species.

The kinds of lustre are—

Metallic.
Adamantine.
Resinous.
Vitreous.
Waxy.
Pearly.
Silky.

And these are farther distinguished as splendent, shining, glistening, glimmering. When no light is distinctly reflected, the mineral is said to be dull.

Metallic lustre belongs to opaque substances, having an index of refraction higher than 2·5. Perfect metallic lustre is that of the metals, pyrites, and some oxides. Of imperfect lustre, tantalite affords an example. Anthracite has generally imperfect, but occasionally, perfect metallic lustre.

Adamantine lustre occurs in diamond and transparent blende, and generally in substances having indices of refraction from 1·9 to 2·5.

Resinous lustre occurs in idocrase, garnet, and other minerals imperfectly transparent, and having refractive indices from 1·7 to 1·9.

Vitreous lustre is that of glass free from lead. It is possessed by quartz, emerald, and other minerals, having refractive indices from 1·3 to 1·8.

Waxy lustre occurs in a few rather soft and nearly opaque minerals.

Pearly lustre occurs principally upon faces of perfect cleavage, as in heulandite, mica, gypsum, and other substances. It is generally seen in only one direction of the crystalline structure, and frequently accompanies incipient decomposition.

Silky lustre usually accompanies fibrous structure.

The lustre of the external faces of crystals frequently differs from that of the cleavage planes, and its intensity appears to depend upon the greater or less degree of purity of the substance and regularity of its structure.

Different kinds of lustre sometimes occur on different faces of the same crystal, not accidentally, but as distinct qualities of the particular faces. Karstenite affords an example of these differences.

REFRACTION.

240. When a ray of light is incident upon any transparent medium, part of the incident light enters the surface, forming the 'refracted ray.' It is found that when a ray is refracted out of air into any transparent liquid or glass, the incident and refracted rays lie in the same plane with a normal to the surface at the point of incidence, and on opposite sides of it; also that the sines of the angles which the incident and refracted rays make with a normal to the surface at the point of incidence, have a ratio depending only on the medium into which the refraction takes place, and the nature of the light.

The sine of the angle of incidence divided by the sine of the angle of refraction is denoted by the quantity μ. This quantity is called the refractive index of the medium.

241. In crystals belonging to the cubic system, the law of re-

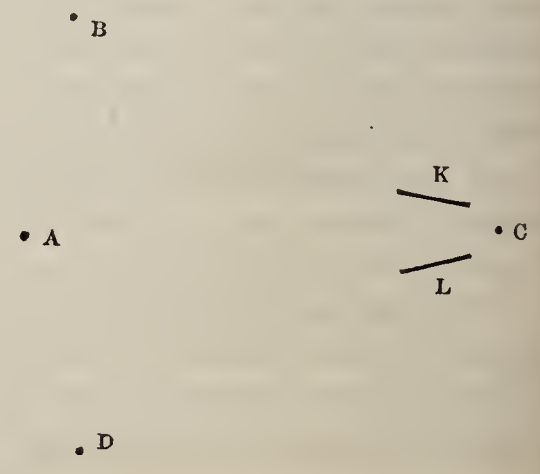
fraction is the same as for a liquid or glass. The index of refraction may be found in the same manner as for glass. Let I be the acute angle between normals to the two planes forming an optical prism, through which light can be refracted; D the minimum deviation of a ray of light of given colour refracted through the prism, in a plane perpendicular to the intersection of its refracting surfaces. Then

$$\mu = \frac{\sin\frac{1}{2}(D + I)}{\sin\frac{1}{2}I}.$$

The image of a bright point seen through a prism is an elongated spectrum, exhibiting the colours of the rainbow, in the order of red, orange, yellow, green, blue, violet, the red end of the spectrum being nearest to the luminous point. The index of refraction usually refers to the brightest part of the spectrum, which lies about the middle of the yellow. When the prism is sufficiently large and perfect, the index may be determined for one or more of the dark lines by which the solar spectrum is crossed, or for the light of the flame of a spirit-lamp, or the bright line in that of a candle, which coincide with Fraunhofer's dark line D.

242. The minimum deviation D may be measured with a theodolite having the telescope fixed with its axis intersecting the axis of the theodolite at right angles, and its object end at such a distance from the axis as to allow the prism to be placed over the centre of the theodolite. The minimum deviation may also be measured in the following manner:—Let a goniometer be fixed with its axis vertical (this may be done by screwing a right-angled knee of metal to the foot of the instrument), having the prism adjusted on it as if for measuring the angle I. Let A be a luminous object, such as a narrow vertical slit, through which is seen the flame of a candle, or of the sun reflected from a mirror, in a plane through the prism perpendicular to the axis of the goniometer; K, L two small vertical plane mirrors of black glass.

FIG. 73.



Turn the axle of the goniometer till the coloured spectrum of A, seen through the prism, appears stationary at B, and move K till the reflexion of A seen in it coincides with B. Next, turn the axle till the spectrum appears stationary at D, and move L till the reflexion of A coincides with D. Now let the image of A, seen by reflexion in one of the faces of the prism, be made to coincide successively with B and D, by turning the graduated circle, and note the angle through which the circle has been turned between the observations. The difference between 180° and this angle is D, the minimum deviation of the spectrum.

243. When light is incident upon the surface of a plate of unsilvered glass, at an angle the tangent of which is equal to the index of refraction of the glass, the reflected light is said to be polarized in the plane of reflexion. If the light incident upon the unsilvered glass has been previously polarized in a plane perpendicular to the plane of incidence, it is not reflected. In any other position of the plane of polarization, or for any other angle of incidence, a portion of it is reflected. The light transmitted through a Nicol's prism is also polarized. The light transmitted through a slice of brown or green tourmaline, bounded by planes parallel to the axis of the rhombohedron, is polarized in a plane perpendicular to the axis of the rhombohedron. When a polarized ray falls upon a Nicol's prism, or a slice of tourmaline, if the Nicol's prism be turned round its axis, or the slice of tourmaline turned in its own plane, two positions will be found in which the plane of polarization of the Nicol's prism, or of the tourmaline, is perpendicular to the plane of polarization of the incident ray, and the light will be stopped; in every other position a portion of the light is transmitted.

244. An approximate value of the index of refraction of any singly refracting substance may be obtained by observing the angle of incidence at which a polished plane surface completely polarizes light.

Adjust the plane surface so as to be in the axis of the goniometer, and turn the graduated circle till the images of A, seen by reflexion in the surface to the right and left of A respectively, are extinguished by a plate of tourmaline, or Nicol's prism, having its plane of polarization parallel to the axis of the goniometer. Half the angle through which the circle has revolved between the observations, is the angle of incidence at which light is completely polarized, and the tangent of this angle is the index of refraction of the substance under examination. Or the incident light may be polarized in a plane parallel to the axis of the goniometer, and the circle turned as before till the reflected images of A vanish in succession.

245. On looking at a bright point through two inclined faces of a prism made of a crystal not belonging to the cubic system, two spectra will be observed.

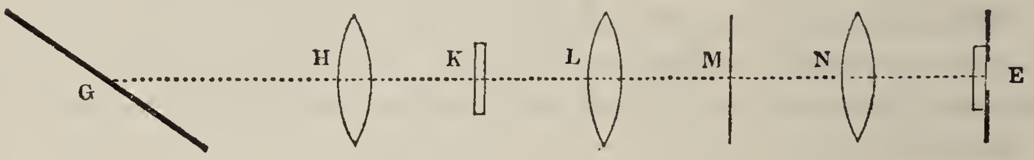
In pyramidal and rhombohedral crystals, one of the spectra is refracted according to the law of sines, as in glass or in cubic crystals. The direction in which this spectrum is seen is called the 'ordinary ray.' The direction in which the other spectrum is seen, 'the extraordinary ray,' is determined by a law too complicated to be described here.

The refraction of the ordinary ray is greater than that of the extraordinary ray, or the extraordinary wave surface is oblate, in the pyramidal crystals, wulfenite, idocrase, anatase, mellite; and in the rhombohedral crystals, nitratine, apatite, calcite, dolomite, pyromorphite, biotite, nepheline, sapphire, tourmaline, cinnabar. It is less than that of the extraordinary ray, or the extraordinary surface is prolate, in the pyramidal crystals, apophyllite, zircon, rutile, cassiterite; and in the rhombohedral crystals, brucite, quartz, hematite, pyrargyrite.

In prismatic, oblique and anorthic crystals, neither ray is refracted according to the law of sines, excepting in particular directions to be noticed presently.

In some crystals, calcite and aragonite, for example,—the doubly-refractive energy is so great, that two images of a near point may be seen on looking through a slice of moderate thickness, bounded by parallel planes. In all cases, if we examine the two images by looking at them through a Nicol's prism, or a plate of tourmaline, it will be found that the two images are polarized, and that the planes of polarization are different.

FIG. 74.



246. The most convenient instrument for examining crystals in polarized light, consists of a mirror of black glass G, called the polarizer, inclined at the polarizing angle to GHLN, the common axis of three lenses H, L, N, of equal focal length (from 1 inch to 1·2 inch each), at distances HL, LN, equal to twice the focal length of one of the lenses, from each other. At E, EN being equal to the focal length of N, is an eye-hole with a plate of tourmaline or a Nicol's prism (called the analyzer), interposed between it and the lens N. At M, the common focus of the lenses L, N, is a micrometer. The slice of crystal to be examined is placed at K, the common focus of the lenses H, L.

When the planes of polarization of the polarizer and analyzer are perpendicular to each other, and the passage of the light wholly intercepted by the analyzer, if a slice of any singly refractive substance, such as glass, or a crystal belonging to the cubic system, be placed at K, no change will occur as to the transmission of light; but if a transparent slice of any doubly refractive crystal (i. e. a crystal not belonging to the cubic system) be placed at K, the passage of the light will be restored, except for particular positions of the crystal.

When a slice of any pyramidal crystal, bounded by planes parallel to the face 001, or of any rhombohedral crystal bounded by planes parallel to the face 111, is placed at K, with its surfaces perpendicular to HKN, a series of concentric coloured rings will be seen, intersected by a black or a white cross, according as the planes of polarization of the polarizer are perpendicular or parallel to each other, or by four sectors in which the rings are dislocated for any other relative position of the polarizer and analyzer. The direction in which the common centre of the system of coloured rings is seen, is called the optic axis of the crystal.

The intervals between the rings are smaller as the thickness of the slice increases, or, the thickness of the slice being the same, as the doubly refractive energy of the crystal increases.

Crystals of the prismatic, oblique and anorthic systems, have two optic axes, round each of which may be seen a series of coloured ovals. These can sometimes be seen together in the field of view of the polarizing instrument; more frequently, however, they can only be seen in succession by turning the crystal.

When the direction of either optic axis meets the surfaces of the slice very obliquely, it remains invisible in air, but can generally be brought into view by immersing it in water or oil contained in a vessel bounded by parallel glass plates.

The goniometer may be used to measure the apparent angular diameters of the coloured rings and the angles which the optic axes appear to make with each other or with normals to any faces of the crystal, the slice of crystal being attached to the goniometer placed with its axis intersecting HKL at right angles at K. When the observations are made in water or oil, the goniometer must be fixed with its axis vertical and the crystal downwards.

247. In pyramidal and rhombohedral crystals, the ordinary ray is refracted according to the law of sines, and its index of refraction may be found in the same manner as that of glass.

An extraordinary ray in a plane perpendicular to the optic axis, or parallel to the face 001, in a pyramidal crystal, and to the face 111, in a rhombohedral crystal, is refracted according to the law of sines, and in this case may be said to have an index of refraction, which may be deduced, by the usual formula, from the minimum deviation of the ray through a prism having its edge parallel to the optic axis. This ray is polarized in a plane perpendicular to the optic axis. An ordinary ray in the same plane is polarized in a plane parallel to the optic axis.

In prismatic crystals, rays in planes parallel to the faces 100, 010, 001, and polarized in those planes, are refracted according to the law of sines, and may therefore be said to have indices of refraction. These indices may be found from the minimum deviations observed through prisms having their edges respectively perpendicular to the faces 100, 010, 001.

In oblique crystals, a ray in a plane parallel to the face 010, and polarized in that plane, is refracted according to the ordinary law. Its index may be computed from its minimum deviation through a prism having its edge perpendicular to the face 010.

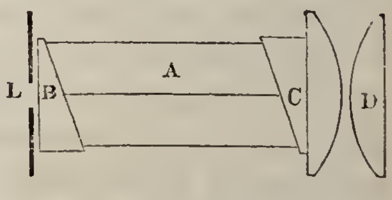
248. Circularly polarized light is obtained by interposing between G and H a lamina of gypsum or mica, of such thickness that for a ray perpendicular to the lamina, the difference of the retardations is a quarter of an undulation, with its planes of polarization making angles of 45° with the plane of reflexion of the mirror G.

PLEOCHROISM.

249. The colours of many crystals, seen by transmitted light, are found to vary with the direction in which they are viewed. Such crystals are called pleochromatic. If the transmitted ray be analyzed by a Nicol's prism, interposed between the crystal and the eye, its colour will be found to vary as the prism (and consequently the plane of polarization of the transmitted light) is turned round its axis.

The difference of colour of two rays, oppositely polarized, is shown in a very striking manner by Haidinger's dichroiscopic prism. It consists of a cleavage rhombohedron of calcite A, having one edge nearly an inch long, the other two edges 0·3 inch each, with glass prisms B, C of 18° each, cemented on the small faces of A. At one end is a convex lens, or combination of lenses, D, of such focal length as to show distinctly an object about 0·4 inch from the end B, seen by an eye at the end D. At B is a stop, having an opening L, about 0·12 inch square.

FIG. 75.



On looking through the prism, with the lens next to the eye, two images of L will be seen just in contact with each other. The light of the image nearest to the edge of the prism B, is polarized in a plane through the short diagonal of A (in the plane of the paper), and the light of the image farthest from the edge of the prism B, is polarized in a plane through the longer diagonal of A (perpendicular to the plane of the paper). The planes of polarization of the two images of the opening may be also known by observing the hour-glass shaped yellowish clouds, discovered by Haidinger, which have their axes in the planes of polarization of the light of the squares in which they are respectively seen.

When a pleochromatic crystal is placed before L, at the distance of distinct vision, and the Haidinger's prism turned round its axis till its planes of polarization coincide with those of the crystal, the two images of the square opening will show the colours of the oppositely polarized pencils of which the transmitted light is composed.

COLOUR.

250. Colours and their varieties, as arranged by Werner for the purpose of being applied to the description of minerals, are as follows :—

Metallic colours.

1. Pinchbeck-brown. Yellowish-brown, with a metallic lustre.
2. Copper-red. The colour of metallic copper.
3. Bronze-yellow. The colour of bronze.
4. Brass-yellow. The colour of ordinary brass.
5. Gold-yellow. The colour of pure gold.
6. Silver-white. The colour of pure silver.
7. Tin-white. The colour of pure tin or antimony.
8. Lead-grey. The colour of pure lead.
9. Steel-grey. The colour of steel on a recent fracture.
10. Iron-black. A blackish grey.

Non-metallic colours.

1. Snow-white. The purest white.
2. Reddish-white. White inclining to red.
3. Yellowish-white. White inclining to yellow.
4. Greyish-white. Pure white, with a tinge of grey arising from the translucency of the substance in which it occurs.
5. Greenish-white. White inclining to greenish-grey.
6. Milk-white. The colour of skimmed milk.

1. Blueish-grey. Grey inclining to blackish-blue.
2. Pearl-grey. Grey mixed with red and blue.
3. Smoke-grey. Brownish-grey, the colour of thick smoke.
4. Greenish-grey. Grey mixed with blackish-green.
5. Yellowish-grey. Grey mixed with yellowish-brown.
6. Ash-grey. The purest grey, a mixture of black and white.

1. Greyish-black. Black inclining to ash-grey.
2. Velvet-black. The purest deep black.
3. Greenish-black. Black somewhat inclining to green.
4. Brownish-black. Black with yellowish-brown.
5. Blueish-black. Black mixed with blue.

1. Blackish-blue. Blue mixed with black.
2. Azure-blue. A very bright, rather reddish blue.
3. Violet-blue. A pure mixture of red and blue.
4. Lavender-blue. Violet-blue mixed with ash-grey.
5. Plum-blue. A reddish violet-blue with brown.
6. Prussian-blue. The purest blue.
7. Smalt-blue. A pure, but pale blue. The colour of a sort of smalt.
8. Indigo-blue. A dark blue with black and green.
9. Duck-blue. Blue, with a great deal of green, and a little black.
10. Sky-blue. A bright, rather greenish blue. The mountain blue of painters.

1. Verdigris-green. Bright green, much inclining to blue.
2. Celandine-green. Blueish-green with grey.
3. Mountain-green. A pale, blueish-green.
4. Leek-green. Green, with a little brown.
5. Emerald-green. The purest green colour.
6. Apple-green. Pale green, with a little yellow.
7. Grass-green. Bright yellowish green.
8. Pistachio-green. Yellowish-green inclining to brown.
9. Asparagus-green. Pale green, with a large proportion of yellow.
10. Blackish-green. Pistachio-green, with much black.
11. Olive-green. Green, with much brown and a little grey and yellow.
12. Oil-green. Green, with much yellow and traces of grey and brown.
13. Siskin-green. Bright green, with much yellow.

1. Sulphur-yellow. The colour of pure crystallized sulphur.
2. Straw-yellow. Pale yellow, with a little grey.
3. Wax-yellow. Yellow, with grey and a little brown.
4. Honey-yellow. Dark yellow, inclining to reddish-brown.
5. Lemon-yellow. The purest yellow colour.
6. Ochre-yellow. Yellow with brown.
7. Wine-yellow. A pale yellow colour, with a little red.
8. Isabella-yellow. Pale yellow, inclining to yellowish-brown.
9. Orange-yellow. Yellow, very much inclining to red.

1. Aurora-red. Red, with a great deal of yellow.
2. Hyacinth-red. Red, inclining to yellowish-brown.
3. Brick-red. Bright red, inclining to yellowish-brown and grey.
4. Scarlet-red. Bright red, with a little yellow.
5. Blood-red. A dark, rather yellowish-red.

6. Flesh-red. A pale, rather yellowish-red.
7. Carmine-red. The pure red colour of carmine.
8. Cochineal-red. Red, with a little blue and grey.
9. Rose-red. Pale carmine-red.
10. Crimson-red. Bright red, with a little blue.
11. Peach-blossom-red. Pale crimson-red in feebly translucent substances.
12. Columbine-red. Dark, blackish crimson-red.
13. Cherry-red. Dark, rather brownish cochineal-red.
14. Brownish-red. Red, with a great deal of brown. The colour of reddle.

1. Reddish-brown. Brown mixed with a great deal of red.
2. Clove-brown. Dark clear brown, inclining to violet-blue.
3. Hair-brown. Brown, with a little yellow and grey.
4. Broccoli-brown. A colour intermediate between liver-brown and violet-blue.
5. Chesnut-brown. The purest brown colour.
6. Yellowish-brown. Brown, with a great deal of yellow.
7. Wood-brown. Brown, with yellow and grey.
8. Liver-brown. Brown, inclining to green.
9. Blackish-brown. Brown, with a great deal of black.

Iridescence is occasionally observable on the surface of minerals, but it is not an essential character.

Opalescence in different degrees is also occasionally observable, exhibiting differently coloured light.

It also occasionally happens, as in a green variety of fluor, that the colour exhibited by transmitted light differs from that occasioned by reflexion. In cordierite, epidote, and many other minerals, the colour by transmitted light varies with the direction in which it is viewed. This property is denoted by the term pleochroism.

PHOSPHORESCENCE.

251. Many varieties of fluor and diamond begin to shine in the dark at a temperature below that of boiling water. Fluor, apatite, dolomite, diamond, many varieties of calcite, and some other minerals, phosphoresce at a temperature below that of red heat. Blende from Kapnik shines when scraped or scratched.

Many varieties of dolomite and calcite frequently emit light when struck with a hammer. Two pieces of quartz phosphoresce when rubbed against each other, either in air or under water.

Gypsum, fluor, calcite, aragonite, amber, and especially some varieties of diamond, become luminous in the dark after exposure to sun-light. After being heated several times, or too strongly, some of these minerals lose the property of phosphorescing, but regain it on having a charge of electricity transmitted through them or over their surfaces.

STREAK.

252. This character may be examined either by scratching the mineral with a point, harder than itself, or, when not too hard, by rubbing it upon a piece of unglazed porcelain. Where it is required only to ascertain the colour of the powder, the rough surface will in many cases suffice, but the point will be found more readily applicable and more generally useful. A writing diamond will scratch all other minerals, but it will be well to use occasionally coarser points, as a fragment of corundum or quartz, or a point of hard steel.

The application of the point may produce a rough or a smooth line, and with or without powder. Where powder is produced, it may be either white or coloured, and, if coloured, it may be of the same tint as the mineral, or different from it. The lustre of the smooth line is sometimes greater than that of the mineral.

The streak is distinguished as shining, dull.

The powder is white, grey, coloured; the same as the mineral, different from it.

SECTILITY AND MALLEABILITY.

253. A few minerals may be cut into *slices* with a knife, and are then termed sectile.

Some may be extended under the hammer; but both of these characters are of very limited use.

FLEXIBILITY.

254. This is a character of very limited application, there being but few minerals that are capable of being bent. Among these, some, as talc, are simply flexible, and retain the bend without any tendency to return to their previous state; while mica is both flexible and elastic. Some minerals also, as kyanite, are flexible from one locality, and not so from another, which precludes this from becoming a generally determinative character.

FRANGIBILITY.

255. This character denotes that condition of minerals which renders them brittle or tough in very different degrees; and,

although the measures of these differences are not laid down, the character itself will be useful when it can be ascertained without destroying the specimen under examination. The usual test is a blow with a hammer.

HARDNESS.

256. This term expresses the degree of force with which the particles of which minerals are composed are held together.

Hardness, denoted by H, is a character of considerable importance in the determination of mineral species, as it may be easily ascertained whenever required. But it is much to be regretted that the comparative hardness of all minerals has not been more exactly ascertained, so as to allow of an arrangement of the entire series in the order of this property.

257. The following is a scale to which the comparative hardness of minerals is commonly referred:—

1. Talc.
2. Rock Salt.
3. Calcite.
4. Fluor.
5. Apatite.
6. Felspar.
7. Quartz.
8. Topaz.
9. Corundum.
10. Diamond.

Generally fragments of transparent or cleavable varieties.

The hardness of calcite is said to be 3; that of topaz 8; and any mineral whose hardness is between that of any two consecutive numbers in the above scale, is regarded as $\frac{1}{4}$, $\frac{1}{2}$, or $\frac{3}{4}$ of the difference between such numbers, or, as it is commonly expressed, ·25, ·5, ·75 harder than the lowest number of the two; but within these limits there is no scale of hardness yet constructed.

The portion of a mineral to be examined should in all respects be pure and perfect, as the slightest degree of decomposition or mixture of foreign matter in one part of a specimen will render the hardness of that part different from that of contiguous portions. The natural external surfaces of minerals are, perhaps, generally harder than the cleavage planes, and the solid angles harder than the flat surfaces. It has also been found, that the hardness differs in different directions of the crystals, it being readily observed in mica that the edge of a plate of this mineral will scratch its plane surface; and, generally, the faces parallel to the best cleavages are the softest.

258. The method hitherto employed for ascertaining the com-

parative hardness of minerals is, by attempting to scratch the substance to be examined by some of the minerals of the above scale, and thus approximating to its degree of hardness; or, with a sharp corner of the substance, try to scratch a smooth surface of the successive members of the scale, beginning at No. 1, if necessary; but for most minerals, not being metallic ones, No. 3 will be sufficiently low.

Where the substance neither scratches nor is scratched by any member of the scale, the hardness of the two minerals is equal. When it scratches the softer, and is scratched by the harder of two consecutive members, a nearer approximation to its relative hardness is required. To ascertain this, let the three minerals be passed successively, with slight pressure, over the surface of a hard fine file, one end of which should be held in the hand, and the other rest on a table, when the different degrees of resistance, and the sound produced, will indicate, with greater or less exactness, the intermediate hardness of the substance examined. The three minerals should nearly correspond in form, size, and surfaces applied to the file. It requires some little practice with the file to be enabled to use it with effect, and some care to preserve it in a state fit for use.

SPECIFIC GRAVITY.

259. This term is used to express the relative weights of equal volumes of different bodies. A volume of distilled water at the temperature of 60° F. or 15·55 C., being employed as the unit with which all others are compared. Thus the specific gravity of water is said to be 1, and that of silver about 10½; meaning, that a mass of silver of equal bulk with any given quantity of water will weigh 10½ times as much as the water.

The method of ascertaining this property of matter is to weigh a portion of the body to be examined in air, and in distilled water, at, or near, the temperature of 60°, when it will be found to weigh less than in air, the difference being equal to the weight of a bulk of water exactly equal to that of the piece of mineral weighed.

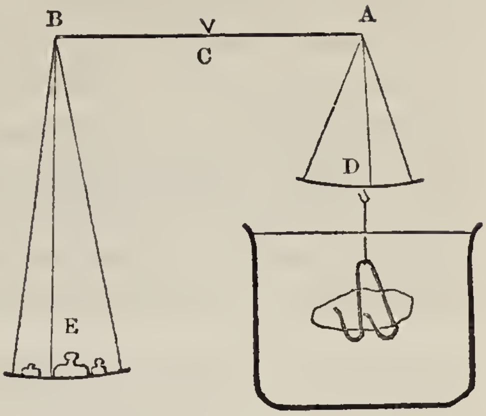
The mineral to be weighed should be free from foreign matter, from disintegration or decay of any kind, and should contain no cavities. When these are suspected, the mineral should be reduced to fragments, or coarse powder.

The specific gravity of a body, in mineralogy, is the ratio of its weight to that of an equal volume of water at a given temperature (usually 60° F., or 15°·55 C.).

The following are the practical methods of finding the specific gravity of minerals:—

260. Let a fragment of the solid be suspended by a hair, or a very fine wire, from a hook on the under side of one of the pans of a delicate balance, the suspending threads of which are shorter than those of the other pan. Let w be weight of the mineral in air, x its apparent weight when suspended in water, G its specific gravity. Then, approximately,

FIG. 76.



$$G = \frac{w}{w - x}.$$

When great accuracy is required, the weight of the air displaced by the mineral must be taken into account. Let this be u. Then

$$G = \frac{w + u}{w + u - x}.$$

FIG. 77.

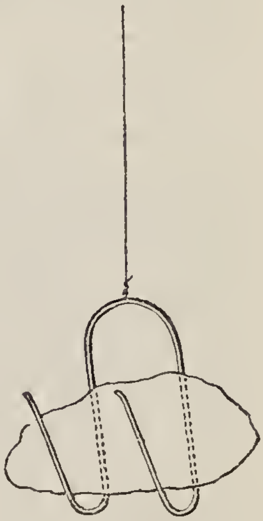
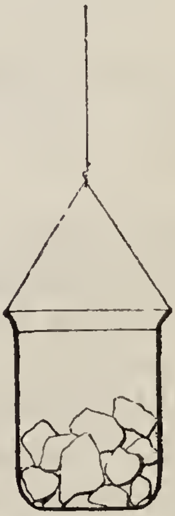


FIG. 78.



A double hook of platinum wire (fig. 77), suspended by a fine wire, may be used for supporting the fragment to be weighed.

When the fragments are too small to be weighed singly, they may be contained in a small cup made of thin glass tube, and held by a wire twisted about the rim (fig. 78), or a thin platinum crucible.

To find x, the apparent weight of the mineral in water, we must subtract the apparent weight of the hook or cup in water, from the apparent weight of the mineral together with the hook or cup, in water. The value of x may also be found in the following manner:—put weights into the pan E till they balance the mineral together with the hook or cup suspended in water from the pan D. Remove the mineral, leaving the hook or cup suspended in water. Then x is the weight which must be placed in D in order to restore the equilibrium.

Bubbles of air are very apt to attach themselves to the mineral when immersed in water; these must be carefully removed before weighing. The only certain way of doing this is, by making the water in which the mineral is suspended, boil briskly for some minutes. The whole must then be left to cool down to nearly the temperature of the air before weighing.

The vessel containing the water should be as large as convenience will allow. When it is too small, the results are apt to be erroneous, in consequence perhaps of a circulation of the water when its temperature differs slightly from that of the air.

261. When the substance floats in water, the double hook must be made to clasp it, and be heavy enough to cause the whole to sink. Proceed to weigh as before; and, approximately,

$$G = \frac{w}{w + x}.$$

Or, u being the weight of the air displaced by the mineral,

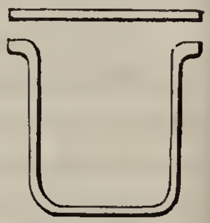
$$G = \frac{w + u}{w + u + x}.$$

To find x, in this case, we must subtract the apparent weight of the hook together with the mineral in water, from the apparent weight of the hook alone in water.

Minerals soluble in water must be weighed in oil, the weight of which, relatively to that of water, must be ascertained.

262. The following method also admits of considerable accuracy:—

FIG. 79.



A glass cup, like the annexed figure, with its rim ground truly plane, provided with a lid of glass, also ground plane, is to be filled with water, closed, and any water adhering to the outside carefully wiped off. The cup is then to be weighed in any delicate balance. Now put the mineral into the cup, close it with the lid, wipe off the water adhering to the outside of the cup, and weigh it as before. Let w be the weight of the mineral; x the weight of the cup filled with water; y the weight of the cup containing the mineral, and filled up with water. Then, approximately,

$$G = \frac{w}{w + x - y}.$$

Or, u being the weight of the air displaced by the mineral,

$$G = \frac{w + u}{w + x + u - y}.$$

The escape of water between the rim of the cup and its lid may be prevented by coating the under surface of the lid with a very thin film of grease, or turpentine. Glass cups should be provided of different sizes, and the smallest used that is capable of containing the mineral.

263. The same cup may be used in finding the specific gravity of a liquid.

Let x be the weight of the lid and cup filled with the liquid,

y the weight of the lid and cup filled with water, w the weight of the lid and empty cup. Then, approximately,

$$G = \frac{x - w}{y - w}.$$

Or, u being the weight of the air contained in the cup,

$$G = \frac{x + u - w}{y + u - w}.$$

264. Where extreme precision is required, the exact temperature of the air and water should be recorded, and the expansibility of the body weighed, relatively to that of water, ascertained.

Specific gravity is an important distinctive character of minerals, and has been observed with much exactness; but as it requires a delicate, and not easily portable apparatus, it cannot be ascertained with sufficient readiness and facility to render it useful in the immediate determination of mineral species. No reliance can be placed upon the very rude estimate of this character when measured only by the hand; and the results of weighing by Nicholson's aræometer, even as improved by Mohs, must be regarded as little more than a rough approximation to the true differences of weight.

MAGNETISM.

265. This property is used in mineralogy only to distinguish some of the ores of iron. A feebly magnetized needle may be employed to ascertain the existence, and the degree and kind, of magnetism in a mineral; and also whether it has polarity, which may be known by its attracting one pole of the needle when one part of the specimen is held towards it, and repelling the same pole when another part is presented to it. Cobalt and nickel are slightly magnetic.

The following substances, called 'magnetic,' are attracted by either pole of a magnet:—Iron, nickel, cobalt, manganese, chromium, cerium, titanium, palladium, platinum, osmium.

The following, called 'diamagnetic,' are repelled by either pole of a magnet:—Bismuth, phosphorus, antimony, zinc, tin, cadmium, sodium, mercury, lead, silver, copper, gold, arsenic, uranium, rhodium, iridium, scheelium.

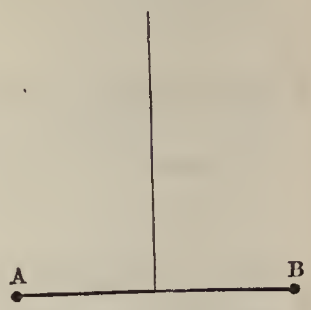
The substances are arranged nearly in the order of the intensity of the power by which they are attracted in the former case, and repelled in the latter.

ELECTRICITY.

266. This is interesting rather as a physical property than a character of much use in either descriptive or determinative

mineralogy. It may be produced in many minerals by friction; in some by heat; and in calcite by pressure.

FIG. 80.



267. The electric needle is a fine metallic wire, having knobs, A, B, at each end, suspended by a dry filament of unspun silk. If a stick of sealing-wax be rubbed with a woollen cloth, and brought near either end of the needle AB, the end of the needle will be attracted by the sealing-wax, and adhere to it. Repeating this process, if requisite, the end of the needle will at last be repelled by the sealing-wax. The needle is now said to be charged with resinous electricity. In like manner, if a rod of glass, rubbed with silk, be brought near either end of the needle, it will at first attract, and finally, repel it. The needle, in this case, is said to be charged with resinous electricity. Two bodies charged with the same kind of electricity repel each other, and two bodies charged with different kinds of electricity attract each other.

A needle charged with either kind of electricity is attracted by all bodies in their natural state, as well as by bodies charged with the opposite kind of electricity; consequently, the only infallible test of the kind of electricity with which any body is charged, is the repulsion of one of the ends of a needle charged with the same kind of electricity.

The resinous electricity is frequently called negative, and the vitreous electricity positive.

Some minerals are conductors, and others non-conductors of electricity.

Nitre, fluor, apatite, aragonite, and epidote are among those which acquire resinous electricity by friction; and sulphur, wolfram, tantalite, mispickel, and oxide of tin among those which acquire vitreous electricity.

The kind of electricity varies also in the same mineral, according to the smoothness or roughness of the surfaces.

268. Some crystals, as long as they are exposed to an increasing temperature, exhibit vitreous electricity at some points of their surface, and resinous electricity at other points. While the temperature is sinking, these points are charged with the opposite electricities. Such crystals are called pyroelectric. The points at which an ascending temperature developes vitreous electricity are called analogous poles by Riess and G. Rose; and the points at which it produces resinous electricity antilogous poles. While the crystal is cooling, the analogous poles exhibit resinous electricity; and the antilogous poles vitreous electricity.

TOUCH.

269. This character is so limited in its application as to be of little service in distinguishing minerals. Steatites have a more or less greasy feel; and dry pulverulent substances, as chalk, are what is termed *meagre* to the touch. Between these extremes there are intermediate degrees and kinds of sensation experienced by the touch, but they are not of sufficient importance to have received much attention from mineralogists.

SMELL.

270. Some minerals emit an earthy smell when breathed upon; others produce peculiar odours when struck with a hammer: that so produced in some of the ores of cobalt and arsenic resembles garlic; those of selenium, when heated, exhale the odour of horseradish; and sulphurets that of sulphur; and some varieties of calcite, which, in consequence, bear the name of stinkstone, give out an offensive smell when broken. But it is a very unimportant character, except as to its being the means of detecting the presence of selenium, arsenic, and sulphur in minerals.

TASTE.

271. This quality is perceivable in only the few soluble substances which are admitted as mineralogical species, and will be noticed in their several descriptions.

CHEMICAL CONSTITUTION.

272. There are known at present sixty-two elementary or undecomposed substances, which, with the exception of some recently discovered, of which the properties are not yet fully ascertained, may be classed as follows:—

1. Non-metallic elements.—Imperfect conductors of electricity and heat.

Gaseous.—Oxygen, hydrogen, nitrogen, chlorine, fluorine.

Liquid.—Bromine.

Solid.—Carbon, phosphorus, sulphur, boron, selenium, iodine, silicon.

2. Metallic elements.—Good conductors of electricity and heat, with the exception of mercury solid.

a. Light metals, having a strong affinity for oxygen.

Metals of alcalies and alcaline earths.—Potassium, sodium, lithium, baryum, strontium, calcium.

Metals of earths.—Magnesium, lanthanium, yttrium, glucium, aluminium, zirconium.

b. Heavy metals.

α. Metals not reducible to a metallic state by heat alone.

Brittle and difficult to fuse.—Thorium, titanium, tantalum, scheelium, molybdenum, vanadium, chrome, uranium, manganese, cerium.

Brittle and easily fusible or volatile.—Arsenic, antimony, tellurium, bismuth.

Malleable.—Zinc, cadmium, tin, lead, iron, cobalt, nickel, copper.

β. Metals reducible by heat.—Mercury, silver, gold, platinum, palladium, rhodium, iridium, osmium.

The remaining substances, the properties of which are not fully known, are didymium, erbium, terbium, niobium, pelopium, norium, ruthenium.

273. *Symbols and Equivalents of the Elements.*

(Taken principally from Fresenius.)

Aluminium	Al	170·42	Nickel	Ni	369·14
Antimony	Sb	1612·90	Niobium	Nb	
Arsenic	As	936·48	Nitrogen	N	175·25
Baryum	Ba	854·85	Norium	Nr	
Bismuth	Bi	2660·75	Osmium	Os	1242·60
Boron	B	136·31	Oxygen	O	100·00
Bromine	Br	999·63	Palladium	Pd	662·54
Cadmium	Cd	696·77	Pelopium	Pl	
Calcium	Ca	250·00	Phosphorus	P	391·55
Carbon	C	75·00	Platinum	Pt	1233·50
Cerium	Ce	590·80	Potash	K	488·94
Chlorine	Cl	443·20	Rhodium	R	652·00
Chrome	Cr	349·83	Ruthenium	Rt	
Cobalt	Co	368·44	Scheelium	W	1188·40
Copper	Cu	396·00	Selenium	Se	495·30
Didymium	D	620·00	Silicon	Si	184·88
Erbium	E		Silver	Ag	1349·01
Fluorine	F	235·71	Sodium	Na	287·17
Glucium	G	58·08	Strontium	Sr	545·60
Gold	Au	2456·72	Sulphur	S	200·00
Hydrogen	H	12·50	Tantalum	Ta	1148·40
Iodine	I	1585·57	Tellurium	Te	801·80
Iridium	Ir	1232·00	Terbium	Tr	
Iron	Fe	350·00	Thorium	Th	743·90
Lanthanium	La	588·00	Tin	Sn	735·30
Lead	Pb	1294·50	Titanium	Ti	301·60
Lithium	L	81·85	Uranium	U	742·90
Magnesium	Mg	157·75	Vanadium	Va	856·90
Manganese	Mn	344·44	Yttrium	Y	402·50
Mercury	Hg	1250·80	Zinc	Zn	406·60
Molybdenum	Mo	596·10	Zirconium	Zr	281·20

274. When any two elements combine chemically, it is found that the weights of the two elements are as some low multiples of the numbers, or 'equivalents,' annexed to them in the preceding table.

Thus one combination of iron and sulphur exists, in which the proportions of the iron and sulphur are as one equivalent, or 350·00 of the former, and one equivalent or 200·00 of the latter; in another combination of the same elements, the proportions of iron and sulphur are as one equivalent, or 350·00 of the former, and two equivalents, or 400·00 of the latter.

In one of the compounds of manganese and oxygen, the proportions of manganese and oxygen have been found as one equivalent, or 344·44 of manganese, and one equivalent, or 100 of oxygen. In another, as two equivalents, or 688·88 of manganese, and three equivalents, or 300·00 of oxygen. In peroxide of manganese, as one equivalent, or 344·44 of manganese, and two equivalents, or 200·00 of oxygen. In manganic acid, as one equivalent, or 344·44 of manganese, and three equivalents, or 300·000 of oxygen; in permanganic acid, as two equivalents, or 688·88 of manganese, and seven equivalents, or 700·00 of oxygen.

A compound of two elements is denoted by the symbols of the two elements; the number of multiples of each, when greater than one, being denoted by figures respectively annexed to them.

Thus FeS denotes the combination of iron and sulphur, consisting of one equivalent of each element; FeS^2 the combination of one equivalent of iron and two equivalents of sulphur; $\mathrm{Mn}^2\mathrm{O}^3$ the combination of two equivalents of manganese and three of oxygen; MnO^3 the combination of one equivalent of manganese and three equivalents of oxygen. In order to abbreviate the symbols, equivalents of oxygen are denoted by dots, one for each equivalent, placed over the symbol of the element with which they are combined; equivalents of sulphur are denoted in like manner by accents. A double equivalent of an element is denoted by its symbol having a dash drawn through it. Thus $\overset{\cdots}{\mathrm{Mn}}$ denotes MnO^3, $\overset{\cdots}{\cancel{\mathrm{Mn}}}$ denotes $\mathrm{Mn}^2\mathrm{O}^3$, $\overset{\prime\prime}{\mathrm{Fe}}$ denotes FeS^2.

The equivalent of a compound of two elements is the sum of the equivalents of its components. Thus the equivalent of protoxide of iron FeO is $350·00 + 100·00 = 450·00$, the equivalent of red oxide of iron $\mathrm{Fe}^2\mathrm{O}^3$ is $2(350·00) + 3(100·00) = 1000·00$.

The law of combination of simple substances applies also to their compounds, which unite with each other in quantities proportional to low multiples of their equivalents. The combination is denoted by the symbols of the compounds having the sign + placed between them, and having the number of multiples of each prefixed.

Thus the mineral proustite, consisting of three equivalents of a sulphide of silver AgS, and one equivalent of a tersulphide of arsenic AsS^3, is denoted by $3AgS + AsS^3$.

275. *Combinations of Simple Substances with Oxygen, and their Equivalents.*

Acids.

Nitric acid	NO^5	$\overset{\cdot\cdot\cdot\cdot\cdot}{N}$	675·25
Sulphuric acid	SO^3	$\overset{\cdot\cdot\cdot}{S}$	500·00
Phosphoric acid	PO^5	$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	891·55
Boracic acid	BO^3	$\overset{\cdot\cdot\cdot}{B}$	436·31
Carbonic acid	CO^2	$\overset{\cdot\cdot}{C}$	275·00
Oxalic acid	C^2O^3	$\overset{\cdot\cdot\cdot}{\not{C}}$	440·00
Silicic acid (Silica)	SiO^2	$\overset{\cdot\cdot}{Si}$	384·88
Arsenious acid	AsO^3	$\overset{\cdot\cdot\cdot}{As}$	1236·48
Arsenic acid	AsO^5	$\overset{\cdot\cdot\cdot\cdot\cdot}{As}$	1436·48
Antimonious acid	SbO^3	$\overset{\cdot\cdot\cdot}{Sb}$	1912·90
Antimonic acid	SbO^5	$\overset{\cdot\cdot\cdot\cdot\cdot}{Sb}$	2312·90
Chromic acid	CrO^3	$\overset{\cdot\cdot\cdot}{Cr}$	649·83
Molybdic acid	MoO^3	$\overset{\cdot\cdot\cdot}{Mo}$	896·10
Vanadic acid	VO^3	$\overset{\cdot\cdot\cdot}{V}$	1156·90
Scheelic acid	WO^3	$\overset{\cdot\cdot\cdot}{W}$	1488·40
Tantalic acid	TaO^3	$\overset{\cdot\cdot\cdot}{Ta}$	1448·40
Titanic acid	TiO^2	$\overset{\cdot\cdot}{Ti}$	501·60
Stannic acid	SnO^2	$\overset{\cdot\cdot}{Sn}$	935·30

Oxides.

Potash	KO	$\dot{K}$	588·94
Soda	NaO	$\dot{Na}$	387·17
Lithia	LiO	$\dot{Li}$	181·85
Strontia	SrO	$\dot{Sr}$	645·6
Barytes	BaO	$\dot{Ba}$	954·85
Lime	CO	$\dot{Ca}$	350·0
Magnesia	MgO	$\dot{Mg}$	257·75
Alumina	AlO^3	$\overset{\cdot\cdot\cdot}{Al}$	640·84
Zirconia	ZrO	$\dot{Zr}$	381·25
Glucine	GO	$\dot{G}$	158·08
Yttria	YO	$\dot{Y}$	502·51
Thoria	ThO	$\dot{Th}$	843·9
Protoxide of cerium	CeO	$\dot{Ce}$	674·7
Oxide of bismuth	BiO^3	$\overset{\cdot\cdot\cdot}{Bi}$	2960·75
Oxide of antimony	SbO^3	$\overset{\cdot\cdot\cdot}{Sb}$	1912·9
Oxide of zinc	ZnO	$\dot{Zn}$	506·59
Protoxide of manganese	MnO	$\dot{Mn}$	444·44
Oxide of manganese	Mn^2O^3	$\overset{\cdot\cdot\cdot}{\not{Mn}}$	988·88

Protoxide of iron	FeO	$\dot{\mathrm{Fe}}$	450·0
Red oxide of iron	$\mathrm{Fe^2O^3}$	$\dddot{\cancel{\mathrm{Fe}}}$	1000·0
Protoxide of uranium	UO	$\dot{\mathrm{U}}$	842·9
Oxide of uranium	$\mathrm{U^2O^3}$	$\dddot{\cancel{\mathrm{U}}}$	1785·8
Oxide of chrome	CrO	$\dddot{\cancel{\mathrm{Cr}}}$	999·66
Oxide of lead	PbO	$\dot{\mathrm{Pb}}$	1394·5
Red oxide of copper	$\mathrm{Cu^2O}$	$\dot{\cancel{\mathrm{Cu}}}$	892·0
Black oxide of copper	CuO	$\dot{\mathrm{Cu}}$	496·0
Oxide of nickel	NiO	$\dot{\mathrm{Ni}}$	469·14
Oxide of cobalt	CoO	$\dot{\mathrm{Co}}$	468·44
Water	HO	$\dot{\mathrm{H}}$	112·5

276. *Proportions of Base and Oxygen in 100 parts of the following Combinations :—*

		Base.	Oxygen.			Base.	Oxygen.
KO	K	83·02	16·98	HgO	Hg	92·60	7·40
NaO	Na	74·17	25·83	$\mathrm{Cu^2O}$	$\mathrm{Cu^2}$	88·79	11·21
LO	li	45·01	54·99	CuO	Cu	79·84	20·16
$\mathrm{NH^4O}$	$\mathrm{NH^4}$	69·25	30·75	$\mathrm{BiO^3}$	Bi	89·87	10·13
BaO	Ba	89·53	10·47	CdO	Cd	87·45	12·55
SrO	Sr	84·51	15·49	$\mathrm{AuO^3}$	Au	89·12	10·88
CaO	Ca	71·43	28·57	$\mathrm{PtO^2}$	Pt	86·05	13·95
MgO	Mg	61·20	38·80	$\mathrm{SbO^3}$	Sb	84·32	15·68
$\mathrm{AlO^3}$	Al	53·19	46·81	SnO	Sn	88·02	11·98
$\mathrm{Cr^2O^3}$	$\mathrm{Cr^2}$	70·11	29·89	$\mathrm{SnO^2}$	Sn	78·62	21·38
ZrO	Zr	80·26	19·74	$\mathrm{AsO^3}$	As	75·74	24·26
MnO	Mn	77·50	22·50	$\mathrm{AsO^5}$	As	65·19	34·81
$\mathrm{Mn^2O^3}$	$\mathrm{Mn^2}$	69·67	30·33	$\mathrm{CrO^3}$	Cr	53·83	46·17
NiO	Ni	78·68	21·32	$\mathrm{SO^3}$	S	40·00	60·00
CoO	Co	78·65	21·35	$\mathrm{PO^5}$	P	43·92	56·08
$\mathrm{Co^2O^3}$	$\mathrm{Co^2}$	71·07	28·93	$\mathrm{BO^3}$	B	31·21	68·76
FeO	Fe	77·78	22·22	$\mathrm{C^2O^3}$	$\mathrm{C^2}$	33·33	66.67
$\mathrm{Fe^2O^3}$	$\mathrm{Fe^2}$	70·00	30·00	$\mathrm{CO^2}$	C	27·27	72·73
AgO	Ag	93·10	6·90	$\mathrm{SiO^2}$	Si	48·03	51·97
PtO	Pt	92·83	7·17	$\mathrm{NO^5}$	N	25·95	74·05
$\mathrm{Hg^2O}$	$\mathrm{Hg^2}$	96·16	3·84	$\mathrm{ClO^5}$	Cl	46·99	53·01

277. *Combinations of Simple Substances with Sulphur, and their Equivalents.*

Tersulphide of antimony	$\mathrm{SbS^3}$	$\overset{\prime\prime\prime}{\mathrm{Sb}}$	2212·9
Tersulphide of arsenic	$\mathrm{AsS^3}$	$\overset{\prime\prime\prime}{\mathrm{As}}$	1536·48
Bisulphide of tin	$\mathrm{SnS^2}$	$\overset{\prime\prime}{\mathrm{Sn}}$	1135·3
Sulphide of lead	PbS	$\overset{\prime}{\mathrm{Pb}}$	1494·5
Sulphide of iron	FeS	$\overset{\prime}{\mathrm{Fe}}$	550·0
Bisulphide of iron	$\mathrm{FeS^2}$	$\overset{\prime\prime}{\mathrm{Fe}}$	750·0
Disulphide of copper	$\mathrm{Cu^2S}$	$\overset{\prime}{\cancel{\mathrm{Cu}}}$	992·0

Sulphide of copper	CuS	Ću	596·0
Sulphide of silver	AgS	Ág	1549·01
Sulphide of zinc	ZnS	Źn	606·59
Sulphide of tin	SnS	Śn	935·3

Dimorphism.

278. The term dimorphism is used to express the property possessed by some substances (both simple and compound), of crystallizing in forms, which have been regarded as constituting different crystalline species. Thus, carbonate of lime, $\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$, crystallizes as calcite in forms belonging to the rhombohedral system, and as aragonite in forms belonging to the prismatic system. Titanic acid, $\ddot{\mathrm{Ti}}$, as brookite, is prismatic; as anatase, pyramidal; as rutile, also pyramidal, but with parameters differing from those of anatase. The following substances also are dimorphous:—C, S, NiAs, HgI, HgCl, FeS^2, $\dddot{\bar{\mathrm{A}}}\mathrm{s}$, $\dddot{\bar{\mathrm{S}}}\mathrm{b}$, $\dot{\mathrm{K}}\dddot{\mathrm{S}}$, $\dot{\mathrm{K}}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{N}}}$, $\dot{\mathrm{N}}\mathrm{i}\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$, $\dot{\mathrm{N}}\mathrm{a}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}\dot{\mathrm{H}}^4$, $\dot{\mathrm{K}}\dddot{\mathrm{S}}\dot{\mathrm{H}}\dddot{\mathrm{S}}$, $\dot{\mathrm{P}}\mathrm{b}\dddot{\mathrm{S}} + 3\dot{\mathrm{P}}\mathrm{b}\ddot{\mathrm{C}}$.

Isomorphism.

279. It was first observed by Mitscherlich, that many groups of substances, simple or compound, having an analogous constitution, crystallize in forms of the same crystalline species, or of species differing but little in their angles. Such groups of substances are said to be isomorphous, homœomorphous, or plesiomorphous.

Thus alumina, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$, red oxide of iron, $\dddot{\bar{\mathrm{Fe}}}$, oxide of chrome, $\dddot{\bar{\mathrm{Cr}}}$, crystallize in forms of the rhombohedral system, the angles of which do not differ more than a few minutes from each other. Carbonate of lime (as calcite) $\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$, of magnesia $\dot{\mathrm{Mg}}\ddot{\mathrm{C}}$, of protoxide of iron $\dot{\mathrm{Fe}}\ddot{\mathrm{C}}$, of protoxide of manganese $\dot{\mathrm{Mn}}\ddot{\mathrm{C}}$, of oxide of zinc $\dot{\mathrm{Zn}}\ddot{\mathrm{C}}$, crystallize in isomorphous forms of the rhombohedral system. Carbonate of lime (as aragonite) $\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$, of barytes $\dot{\mathrm{Ba}}\ddot{\mathrm{C}}$, of strontia $\dot{\mathrm{Sr}}\ddot{\mathrm{C}}$, of oxide of lead $\dot{\mathrm{Pb}}\ddot{\mathrm{C}}$, crystallize in isomorphous forms of the prismatic system. Sulphate of barytes $\dot{\mathrm{Ba}}\dddot{\mathrm{S}}$, of strontia $\dot{\mathrm{Sr}}\dddot{\mathrm{S}}$, of oxide of lead $\dot{\mathrm{Pb}}\dddot{\mathrm{S}}$, have isomorphous forms of the prismatic system. Hydrous sulphate of soda $\dot{\mathrm{Na}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^{10}$, seleniate of soda $\dot{\mathrm{Na}}\dddot{\mathrm{Se}}\dot{\mathrm{H}}^{10}$, and chromate of soda $\dot{\mathrm{Na}}\dddot{\mathrm{Cr}}\dot{\mathrm{H}}^{10}$, have isomorphous forms belonging to the oblique system. Sulphate of potash $\dot{\mathrm{K}}\dddot{\mathrm{S}}$, seleniate of potash $\dot{\mathrm{K}}\dddot{\mathrm{Se}}$, chromate of potash $\dot{\mathrm{K}}\dddot{\mathrm{Cr}}$, manganate of potash $\dot{\mathrm{K}}\dddot{\mathrm{Mn}}$, have isomorphous forms of the prismatic system. Gypsum $\dot{\mathrm{Ca}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^2$, sulphate of iron, with two equivalents of water, $\dot{\mathrm{Fe}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^2$, hydrous seleniate of lime $\dot{\mathrm{Ca}}\dddot{\mathrm{Se}}\dot{\mathrm{H}}^2$, have isomorphous forms of the oblique system. Sulphate of soda $\dot{\mathrm{Na}}\dddot{\mathrm{S}}$, seleniate of soda $\dot{\mathrm{Na}}\dddot{\mathrm{Se}}$, sulphate of oxide of silver $\dot{\mathrm{Ag}}\dddot{\mathrm{S}}$, seleniate of oxide of silver $\dot{\mathrm{Ag}}\dddot{\mathrm{Se}}$, have isomorphous forms of the prismatic system. Seleniate of oxide of copper $\dot{Cu}\dddot{Se}\dot{H}^5$, sulphate of oxide of copper $\dot{Cu}\dddot{S}\dot{H}^5$, sulphate of protoxide of manganese $\dot{Mn}\dddot{S}\dot{H}^5$, have isomorphous forms of the anorthic system. Antimony, bismuth, arsenic, and tellurium crystallize in isomorphous rhombohedrons. $\dddot{\bar{Sb}}$ and $\dddot{\bar{As}}$ crystallize in isomorphous forms of the prismatic system, and also in octahedrons.

The following table, extracted principally from Frankenheim's 'System der Krystalle,' exhibits most of the isomorphous groups known at present:—

Cubic.

Cu ; Ag ; Au.

Cd ; Pb ; Hg ; Pd.

PbS ; $PbSe$; $PbTe$.

AgS ; $AgSe$; $AgTe$.

Cu^2S ; AgS.

FeS^2 ; MnS^2.

$CoAs$; $NiAs$.

Ni^2As ; Ni^2Sb.

$CoS^2 + CoAs$;
$NiS^2 + NiAs$;
$NiS^2 + NiSb$.

$\acute{\cancel{Cu}}^4\overset{\prime\prime\prime}{\bar{A}}s + \acute{Fe}^4\overset{\prime\prime\prime}{\bar{A}}s$;
$\acute{\cancel{Cu}}^4\overset{\prime\prime\prime}{\bar{A}}s + \acute{R}^4\overset{\prime\prime\prime}{\bar{S}}b$.

$\dot{Mg}\dddot{\bar{Al}}$; $\dot{Zn}\dddot{\bar{Al}}$; $\dot{Mn}\dddot{\bar{Al}}$; $\dot{Co}\dddot{\bar{Al}}$; $\dot{Zn}\dddot{\cancel{Fe}}$;
$\dot{Mg}\dddot{\cancel{Fe}}$; $\dot{Fe}\dddot{\cancel{Fe}}$; $\dot{Fe}\dddot{\cancel{Cr}}$; $\dot{Mg}\dddot{\cancel{Cr}}$.

$\dddot{\bar{As}}$; $\dddot{\bar{Sb}}$.

$\dot{K}\dddot{S} + \dddot{\bar{Al}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{Na}\dddot{S} + \dddot{\bar{Al}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{Li}\dddot{S} + \dddot{\bar{Al}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{N}H^4\dddot{S} + \dddot{\bar{Al}}\dddot{S}^3 + \dot{H}^{24}$

$\dot{K}\dddot{S} + \dddot{\cancel{Fe}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{Na}\dddot{S} + \dddot{\cancel{Fe}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{Li}\dddot{S} + \dddot{\cancel{Fe}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{N}H^4\dddot{S} + \dddot{\cancel{Fe}}\dddot{S}^3 + \dot{H}^{24}$

$\dot{K}\dddot{S} + \dddot{\cancel{Cr}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{Na}\dddot{S} + \dddot{\cancel{Cr}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{Li}\dddot{S} + \dddot{\cancel{Cr}}\dddot{S}^3 + \dot{H}^{24}$
$\dot{N}H^4\dddot{S} + \dddot{\cancel{Cr}}\dddot{S}^3 + \dot{H}^{24}$

$\dot{Ca}\ddot{Si}^2 + \dddot{\bar{Al}}\ddot{Si}$
$\dot{Mg}\ddot{Si}^2 + \dddot{\bar{Al}}\ddot{Si}$
$\dot{Fe}\ddot{Si}^2 + \dddot{\bar{Al}}\ddot{Si}$
$\dot{Mn}\ddot{Si}^2 + \dddot{\bar{Al}}\ddot{Si}$
$\dot{Ca}\ddot{Si}^2 + \dddot{\cancel{Fe}}\ddot{Si}$
$\dot{Ca}\ddot{Si}^2 + \dddot{\cancel{Cr}}\ddot{Si}$

$\dot{Co}\dot{P}\dot{H}^8$; $\dot{Ni}\dot{P}\dot{H}^8$; $\dot{Mg}\dot{P}\dot{H}^8$.

$\dot{K}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{Br}}$; $\dot{Na}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{Cl}}$; $\dot{N}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{Br}}$.

$\dot{Ba}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{N}}$; $\dot{Sr}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{N}}$; $Pb\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{N}}$.

KNC^2 ; NH^4NC^2.

CaF ; KCl ; $LiCl$; $AgCl$; KBr ;
KI ; $NaCl$; $NaBr$; NaI ; KF ;
NaF ; YBr ; YI ; ZrI ; NH^4Cl.

$KCl + PtCl^2$
$KCl + PbCl^2$
$KCl + IrCl^2$
$KCl + OsCl^2$
$KCl + SnCl^2$
$NaCl + SnCl^2$
$NH^4Cl + PtCl^2$
$NH^4Cl + PdCl^2$
$NH^4Cl + IrCl^2$
$NH^4Cl + SnCl^2$
$KBr + PtBr^2$

$\mathrm{\dot{Zn}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{Br}}\dot{H}^{6}}$; $\mathrm{\dot{Mg}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{Br}}\dot{H}^{6}}$.

$\mathrm{\dot{Mg}^{3}\ddot{\bar{B}}^{4}}$; $\mathrm{\dot{Ca}}$, $\mathrm{\ddot{\bar{B}}}$.

$\mathrm{KNC^{2} + CdNC^{2}}$
$\mathrm{KNC^{2} + ZnNC^{2}}$
$\mathrm{KNC^{2} + AgNC^{2}}$
$\mathrm{KNC^{2} + HgNC^{2}}$

Pyramidal.

$\mathrm{\ddot{Ti}}$; $\mathrm{\ddot{Sn}}$.

$\mathrm{\dot{Ni}\dddot{S}\dot{H}^{7}}$; $\mathrm{\dot{Ni}\dddot{Se}\dot{H}^{7}}$; $\mathrm{\dot{Zn}\dddot{Se}\dot{H}^{7}}$.

$\mathrm{CuClKCl\dot{H}^{2}}$; $\mathrm{CuClNH^{4}Cl\dot{H}^{2}}$.

$\mathrm{\dot{Ag}\dddot{S}2NH^{3}}$; $\mathrm{\dot{Ag}\dddot{Se}2NH^{3}}$; $\mathrm{\dot{Ag}\dddot{Cr}2NH^{3}}$.

$\mathrm{\dot{Pb}\dddot{Mo}}$; $\mathrm{\dot{Pb}\dddot{W}}$; $\mathrm{\dot{Ca}\dddot{W}}$.

$\mathrm{\dot{N}H^{4}\dot{H}^{2}c\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}}}$; $\mathrm{\dot{N}H^{4}\dot{H}^{2}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{As}}}$
$\mathrm{\dot{K}\dot{H}^{2}c\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}}}$; $\mathrm{\dot{K}\dot{H}^{2}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{As}}}$.

$\mathrm{\dot{\cancel{Cu}}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}} + 2\ddot{\cancel{U}}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}} + \dot{H}^{3}}$
$\mathrm{\dot{Ca}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}} + 2\ddot{\cancel{U}}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}} + \dot{H}^{8}}$

$\mathrm{2NH^{4}NC^{2}\dot{H} + FeNC^{2}\dot{H}}$
$\mathrm{2KHC^{2}\dot{H} + FeNC^{2}\dot{H}}$

Rhombohedral.

As ; Bi ; Sb ; Te ; OsIr

$\mathrm{\overset{\prime}{Ag}^{3}\overset{\prime\prime\prime}{Sb}}$; $\mathrm{\overset{\prime}{Ag}^{3}\overset{\prime\prime\prime}{\overline{As}}}$

$\mathrm{\ddot{\cancel{Cr}}}$; $\mathrm{\dddot{\overline{Al}}}$; $\mathrm{\dddot{\cancel{Fe}}}$; $\mathrm{\dddot{\cancel{Ti}}}$

$\mathrm{3\dot{Pb}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}} + PbCl}$
$\mathrm{3\dot{Pb}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{As}} + PbCl}$
$\mathrm{3\dot{Ca}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}} + CaF}$

$\mathrm{\dot{Ca}\ddot{C}}$; $\mathrm{\dot{Mg}\ddot{C}}$; $\mathrm{\dot{Fe}\ddot{C}}$; $\mathrm{\dot{Zn}\ddot{C}}$; $\mathrm{\dot{Mn}\ddot{C}}$

$\mathrm{RCl + PtCl^{2}\dot{H}^{6}}$,
where R is Mg, Zn, Cd, Fe, Mn, Ni, Co, Cu.

$\mathrm{\dot{Sr}S^{2}O^{5}\dot{H}^{4}}$; $\mathrm{\dot{Ca}S^{2}O^{5}\dot{H}^{4}}$; $\mathrm{\dot{Pb}S^{2}O^{5}\dot{H}^{4}}$

$\mathrm{2NH^{4}Cl + BiCl^{3}}$
$\mathrm{2NH^{4}Cl + SbCl^{3}}$

$\mathrm{2\dot{K}\dddot{\cancel{Fe}}\dddot{S}^{4}\dot{H}^{7}}$
$\mathrm{2\dot{N}H^{4}\dddot{\cancel{Fe}}\dddot{S}^{4}\dot{H}^{7}}$

$\mathrm{\cancel{Fe}NC^{2} + 2NH^{4}NC^{2} + NH^{4}Br}$
$\mathrm{\cancel{Fe}NC^{2} + 2NH^{4}NC^{3} + NH^{4}Cl}$

Prismatic.

$\mathrm{\dddot{\overline{Sb}}}$; $\mathrm{\dddot{\overline{As}}}$.

$\mathrm{Cu^{2}S}$; $\mathrm{Cu^{2}S}$, AgS.

$\mathrm{\ddot{\cancel{Mn}}\dot{H}}$; $\mathrm{\dddot{\cancel{Fe}}\dot{H}}$; $\mathrm{\dddot{\overline{Al}}\dot{H}}$.

$\mathrm{\dot{Mn}^{2}\ddot{Si}}$; $\mathrm{\dot{Mg}^{2}\ddot{Si}}$; $\mathrm{\dot{Fe}^{2}\ddot{Si}}$.

$\mathrm{\dot{K}\dddot{Cr}}$; $\mathrm{\dot{K}\dddot{Se}}$; $\mathrm{\dot{K}\dddot{Mn}}$; $\mathrm{\dot{K}\dddot{S}}$; $\mathrm{\dot{N}H^{4}\dddot{S}}$.

$\mathrm{\dot{Ba}\dddot{S}}$; $\mathrm{\dot{Sr}\dddot{S}}$; $\mathrm{\dot{Pb}\dddot{S}}$.

$\mathrm{\dot{Mg}\dddot{S}\dot{H}^{7}}$; $\mathrm{Mg\dddot{Se}\dot{H}^{7}}$; $\mathrm{\dot{Zn}\dddot{Se}\dot{H}^{7}}$;
$\mathrm{\dot{Zn}\dddot{S}\dot{H}^{7}}$; $\mathrm{\dot{Ni}\dddot{S}\dot{H}^{7}}$; $\mathrm{\dot{Mg}\dddot{Cr}\dot{H}^{7}}$.

$\mathrm{\dot{Ag}\dddot{Se}}$; $\mathrm{\dot{Na}\dddot{Se}}$; $\mathrm{\dot{Ag}\dddot{S}}$; $\mathrm{\dot{Na}\dddot{S}}$.

$\mathrm{\dot{K}\dddot{S} + \dot{H}\dddot{S}}$
$\mathrm{\dot{K}\dddot{Se} + \dot{H}\dddot{Se}}$

$\mathrm{\dot{Cu}^{4}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{As}}\dot{H}}$; $\mathrm{\dot{Cu}^{4}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{P}}\dot{H}}$

$\mathrm{KCl + HgCl\dot{H}}$
$\mathrm{NH^{4}Cl + HgCl\dot{H}}$

$\mathrm{\dot{Na}C^{4}H^{2}O^{5} + \dot{K}C^{4}H^{2}O^{5} + \dot{H}^{8}}$
$\mathrm{\dot{Na}C^{4}H^{2}O^{5} + \dot{N}H^{4}C^{4}H^{2}O^{5} + \dot{H}^{8}}$.

$\dddot{\bar{Sb}}C^4H^2O^5 + \dot{K}C^4H^2O^5 + \dot{H}^2$
$\dddot{\bar{Sb}}C^4H^2O^5 + \dot{N}H^4C^4H^2O^5 + \dot{H}^2$
$\dddot{\bar{Te}}C^4H^2O^5 + \dot{K}C^4H^2O^5 + \dot{H}^2$
$\dddot{\bar{As}}C^4H^2O^5 + \dot{K}C^4H^2O^4 + \dot{H}^2$

$\dot{K}C^4H^2O^5 + \ddot{H}C^4H^2O^5$
$\dot{N}H^4C^4H^2O^5 + \dot{H}C^4H^2O^5$

$3KNC^2 + R^2 3NC^2$
where R is Fe, Mn or Co

$\dot{K}\overset{\cdot\cdot\cdot\cdot\cdot\cdot\cdot}{\bar{Mn}} + \dot{H}\overset{\cdot\cdot\cdot\cdot\cdot\cdot\cdot}{\bar{Mn}}$
$\dot{N}H^4\dddot{S} + \dot{H}\dddot{S}$

$\dot{Sr}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{Br}}\dot{H}$; $\dot{Pb}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{Br}}\dot{H}$

$\dot{Ag}S^2O^5\dot{H}^2$; $\dot{Na}S^2O^5H^2$

$\dot{Na}c\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}\dot{H}^4$; $\dot{Na}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\dot{H}^4$

$\dot{K}ClO^7$; $\dot{K}Mn^2O^7$
$\dot{N}H^4ClO^7$; $\dot{N}H^4Mn^2O^7$

$BaCl\dot{H}^2$; $BaBr\ddot{H}^2$

$\dot{Fe}\dddot{S}\dot{H}^4$; $\dot{Mn}\dddot{S}\dot{H}^4$

Oblique.

$\dot{Ca}\dddot{Se}\dot{H}^2$; $\dot{Ca}\dddot{S}\dot{H}^2$; $\dot{Fe}\dddot{S}\dot{H}^2$.

$\dot{Co}\dddot{S}\dot{H}^7$; $\dot{Fe}\dddot{S}\dot{H}^7$; $\dot{Mn}\dddot{S}\dot{H}^7$.

$\dot{K}\dddot{S}\dot{Fe}\dddot{S}\dot{H}^6$
$\dot{K}\dddot{S}\dot{Cu}\dddot{S}H^6$
$\dot{K}\dddot{S}\dot{Ni}\dddot{S}\dot{H}^6$
$\dot{K}\dddot{S}\dot{Zn}\dddot{S}\dot{H}^6$
$\dot{N}H^4\dddot{S}\dot{Fe}\dddot{S}\dot{H}^6$
$\dot{N}H^4\dddot{S}\dot{Mg}\dddot{S}\dot{H}^6$
$\dot{N}\dot{H}^4\dddot{S}\dot{Cu}\dddot{S}\dot{H}^6$
$\dot{N}\dot{H}^4\dddot{S}\dot{Ni}\dddot{S}\dot{H}^6$

$\dot{Fe}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}\dot{H}^8$
$\dot{Co}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\dot{H}^8$
$\dot{Fe}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\dot{H}^8$
$\dot{Zn}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\dot{H}^8$
$\dot{Ni}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\dot{H}^8$

$\dot{Pb}\bar{A}\dot{H}^3$; $\dot{Ba}\bar{A}\dot{H}^3$

$NaCl\dot{H}^4$; $NaBr\dot{H}^4$; $NaI\dot{H}^4$

$\dot{K}\ddot{C}^4\dot{H}$; $\dot{N}H^4\ddot{C}^2\dot{H}$

$2\dot{N}H^4 + c\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}} + \dot{H}$; $2\dot{N}H^4 + \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}} + \dot{H}$.

$\dot{Na}^2c\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}\dot{H}^{25}$; $\dot{Na}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\ddot{H}^{25}$

$\dot{Na}\dot{N}H^4c\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}\dot{H}^9$
$\dot{Na}\dot{N}H^4\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\dot{H}^9$

$\dot{Na}\dddot{S}\dot{H}^{10}$; $\dot{Na}\dddot{Se}\dot{H}^{10}$; $\dot{Na}\dddot{Cr}\dot{H}^{10}$

$2\dot{Na}c\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}\dot{H}^{15}$
$2\dot{Na}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\dot{H}^{15}$

$R^2O^3 3C^2O^3 + 3\dot{K}C^2O^3 + \dot{H}^6$
$R^2O^3 3C^2O^3 + 3\dot{N}H^4C^2O^3 + \dot{H}^6$
where R^2 is Fe^2, Cr^2 or Al.

$R^2 3NC^2 + 3KNC^2$
$R^2 3NC^2 + 3NH^4NC^2$
where R is Fe, Co, Mn or Cr.

$RClHgCl\dot{H}^4$
where R is Mn, Fe or Co.

$2\dot{N}H^4 + \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}\dot{H}^3$
$2\dot{N}H^4 + \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\dot{H}^3$

Anorthic.

$\dot{Ag}\dddot{Cr}^2$
$\dot{K}\dddot{Cr}^2$

$\dot{Cu}\dddot{Se}\dot{H}^5$
$\dot{Cu}\dddot{S}\dot{H}^5$
$\dot{Mn}\dddot{S}\dot{H}^5$

$\dot{K}4C^2O^3 + \dot{H}^7$
$\dot{N}H^4 4C^2O^3 + \dot{H}^7$

280. An exception, rather apparent than real, to the laws stated in (274), is presented by some isomorphous substances which are found to crystallize together in all proportions.

A mixed solution of sulphate of oxide of copper ($\dot{\mathrm{Cu}}\dddot{\mathrm{S}}$) and sulphate of oxide of zinc ($\dot{\mathrm{Zu}}\dddot{\mathrm{S}}$), yields crystals having the form of sulphate of protoxide of iron ($\dot{\mathrm{Fe}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$), in which the oxides of copper and zinc occur in variable proportions. The oxygen of the sulphuric acid is three times, and that of the water contained in the crystals seven times as great as the oxygen contained in the oxides of copper and zinc together. The constitution of such a crystal is represented by the symbol ($\dot{\mathrm{Cu}}$,$\dot{\mathrm{Zn}}$) $\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$, which may be regarded as an abbreviation of the more correct representation ($\dot{\mathrm{Cu}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$),($\dot{\mathrm{Zn}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$). This mixture is described verbally by saying, that a portion of the oxide of copper is replaced by oxide of zinc.

A crystal of the mixed sulphate of oxide of copper and sulphate of oxide of zinc with seven equivalents of water, placed alternately in a saturated solution of sulphate of protoxide of iron, with which it is isomorphous, and of the sulphates of oxide of copper and zinc, was found to be enlarged by alternate green and blue layers, the former being pure sulphate of protoxide of iron, $\dot{\mathrm{Fe}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$, and the latter the mixed sulphates of oxides of copper and zinc ($\dot{\mathrm{Cu}}$,$\dot{\mathrm{Zn}}$) $\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$.

Perhaps the crystals formed in the mixed solution of sulphates of oxides of copper and zinc may, in like manner, consist of a mechanical mixture of portions of pure $\dot{\mathrm{Cu}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$ and $\dot{\mathrm{Zn}}\dddot{\mathrm{S}}\dot{\mathrm{H}}^7$, but too minute to be distinguished from each other. On this hypothesis, however, we must assume that the presence of the sulphate of oxide of zinc influences the sulphate of oxide of copper so as to make it combine with seven equivalents of water instead of five, the proportion with which it unites under ordinary circumstances.

Sulphate of oxide of copper crystallizes also, in all proportions, with sulphates of magnesia, sulphate of oxide of nickel, sulphate of oxide of cobalt, sulphate of protoxide of iron, in the form of the latter salt, and, like it, with seven equivalents of water. So also potash and alumina alum, $\dot{\mathrm{K}}\dddot{\mathrm{S}} + \dddot{\mathrm{Al}}\dddot{\mathrm{S}} + \dot{\mathrm{H}}^{24}$, and potash and chrome alum, $\mathrm{K}\dddot{\mathrm{S}} + \dddot{\bar{\mathrm{C}}\mathrm{r}}\,\dddot{\mathrm{S}} + \dot{\mathrm{H}}^{24}$, and chloride and iodide of potassium crystallize together.

Numerous other examples are presented by crystallized minerals.

The true constitution of a mineral is sometimes disguised by a mechanical mixture of impurity, derived from the solution out of which it crystallized. When a solvent can be found capable of acting either upon the mineral or the impurity, but not upon both, the impurity may easily be detected as such. Thus, graphite usually contains a mechanical mixture of iron, which may be completely removed by hydrochloric acid, leaving the graphite unaltered. Some varieties of calcite contain a large admixture of quartz, which is left as sand when the calcite is dissolved by hydrochloric acid. When no solvent can be found that does not act equally upon the mineral and the impurity, the separation of the essential constituents of a mineral from those which are non-essential presents considerable difficulty.

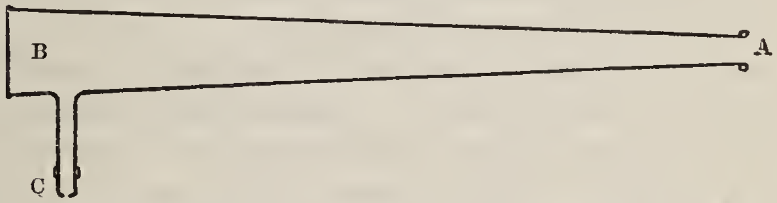
On the Chemical Reactions of Minerals.

281. By chemical reactions are understood the appearances and changes which minerals show when they are qualitatively tested either in the dry or moist way. Such operations only are requisite as can be performed with small and simple apparatus on very small quantities of the mineral.

Testing in the Dry Way.

282. Testing the fusibility and the volatile ingredients of a mineral.

FIG. 81.



The blowpipe, in its best form, consists of a metal tube, AB, of about three times the dimensions of the annexed figure, open at A, and closed at B, with a small tube, BC, at right angles to AB, ending at C in a cap, at the end of which is an aperture of about $\frac{1}{80}$ of an inch in diameter. The end, A, being applied to the lips, and the mouth kept filled with air, an uninterrupted current of air is forced through C by the action of the muscles of the cheeks.

For testing minerals in the dry way, the heat of the flame of a lamp or candle is concentrated on a small space, and rendered more intense by the stream of air directed through the blowpipe. The fragment of the mineral to be examined, or the assay, as it is sometimes called, should not be larger than a grain of hemp-seed. It is exposed to the flame held in forceps tipped with platinum, or by a platinum wire, or supported on platinum foil, or on a bit of well-burnt charcoal.

The flame of a lamp urged by a blowpipe consists of a blue cone, surrounded by a bright yellow flame. A little beyond the blue point, where the flame is hottest, it has a tendency to reduce metallic oxides; at the extremity of the yellow flame it oxidates. The assay is exposed to the flame either alone or with the addition of different reagents, and the qualitative chemical composition is inferred from the various appearances which present themselves.

The assay may be heated alone, in a glass tube closed at one end, over the flame of a spirit-lamp, in order to discover whether any thing is volatilized without free access of atmospheric air. By this experiment it may be ascertained whether water, mercury, arsenic, tellurium, and, in many cases, whether sulphur or fluorine are present in the mineral.

The assay is heated alone, in a glass tube open at both ends, in order to see whether, when freely exposed to the air, volatile oxides or acids are formed and expelled. In this manner, for example, most of the compounds of sulphur, selenium, tellurium, and arsenic may be recognized.

The assay is heated on charcoal in order to discover the presence of arsenic (in the inner flame), or of sulphur and selenium (in the outer flame), which betray themselves by their smell. Antimony, zinc, lead, and bismuth are known by the deposit that is formed upon the charcoal round the assay. Many oxides and sulphurets are reduced to a metallic state.

The assay is heated alone in the forceps, on platinum wire, or on charcoal, to determine its fusibility; other appearances, such as frothing, intumescence, shining, colour of the flame, are to be noted at the same time.

Minerals differ extremely in their fusibility. Some melt readily in large grains; others more difficultly; others, again, only in fine splinters; and many are perfectly infusible before the blowpipe. The nature of the result of fusion is also to be observed, whether it appears as a glass, clear, or full of bubbles, as enamel, or as a slag. v. Kobell expresses the degree of fusibility of a mineral numerically, by comparing its fusibility with that of one of the minerals in the following scale:—

(1) Antimonite, (2) natrolite, (3) almandine, (4) actynolite, (5) orthoclase, (6) bronzite.

The most important reagents used in testing minerals with the blowpipe are the following:—

(1.) Soda (carbonate of soda) is used for dissolving silica and many silicates, and the reduction of metallic oxides. For reduction, the assay is ground to powder, made into a paste with soda, and exposed to the inner flame on charcoal. Usually the soda sinks into the charcoal. The portion of charcoal into which the soda has penetrated must be reduced to a very fine powder, with water, in an agate mortar, and the charcoal-dust carefully washed away. If the assay contained a reducible metal, it will be left behind in the mortar in spangles or powder, according as the metal is or is not malleable. Fresenius recommends a mixture of equal parts of sods and cyanide of potassium for reducing metallic oxides.

(2.) Borax (borate of soda). It should be fused into a bead at the end of a bit of platinum wire, bent so as to form a hook. A very small fragment of mineral being added to it, one observes whether it is dissolved easily or with difficulty, with or without ebullition, and the colour, if any, imparted to the bead, as well in the outer as in the inner flame.

(3.) Salt of phosphorus (phosphate of soda and ammonia), used on platinum wire, like borax, serves to distinguish metallic oxides, as the colours which it derives from them are much more decided than those of borax. It is also a good reagent for silicates, the silica of which is separated from the bases, and remains undissolved in the melted salt of phosphorus.

(4.) Boracic acid is used to detect phosphoric acid.

(5.) Anhydrous bisulphate of potash is used to detect lithia, boracic acid, bromine, and iodine.

(6.) Gypsum and fluorspar are employed as tests for each other, being fusible together into a bead, which is transparent while hot, but opaque when cold.

(7.) Solution of nitrate of oxide of cobalt, or dry oxalate of oxide of cobalt, serves to detect alumina, magnesia, and oxide of zinc.

(8.) Oxalate of oxide of nickel is used to discover potash in minerals which at the same time contain soda and lithia.

(9.) Tin, in the form of strips of tin foil, promotes the complete reduction of metallic oxides.

(10.) Iron, in the form of very fine wire, is used for detecting phosphoric acid.

(11.) Silica, with soda, is a test for sulphur and sulphuric acid.

(12.) Oxide of copper is used for detecting chlorine and iodine.

(13.) Litmus, brazilwood, and turmeric paper.

Testing Minerals in the Moist Way.

283. The testing of minerals in the moist way is based upon the mutual action of different acids and bases when they come in contact with each other in a watery solution. Consequently, the mineral to be examined, if not already, in its natural state, capable of being dissolved in water, must be rendered soluble. Accordingly, minerals may be divided into three groups, as follows:—

(1.) Minerals soluble in water—hydrolytes.

(2.) Minerals soluble in hydrochloric acid or nitric acid.

(3.) Minerals which are not soluble in water, nor in the above-mentioned acids.

The minerals soluble in water are either acids, or oxygen salts, or haloids. Their constituents are usually easily discovered. Boracic and arsenious acids are almost the only acids that occur. In testing the salts that belong to this group, one uses part of the solution for finding out the base, or electro-positive ingredient, and another part for finding out the electro-negative ingredient.

The bases which occur in the mineral hydrolytes hitherto discovered are, ammonia, potash, soda, lime, magnesia, alumina, protoxide and peroxide of iron, oxides of zinc, copper, cobalt, uranium, and mercury. The electro-negative constituents are carbonic, sulphuric, nitric, and boracic acids, and chlorine.

When a mineral is found to be insoluble in water, we must endeavour to dissolve it in hydrochloric or nitric acid. The latter is to be preferred when the appearance of the mineral, or preliminary experiments with the blowpipe, lead to the supposition that it is a metallic alloy, a sulphide, or an arsenide. In this manner the carbonates, phosphates, arseniates, chromates, and many hydrous and anhydrous silicates, many sulphides, arsenides, and other metallic compounds, are decomposed and rendered soluble in water. The constituents of the solution thus obtained may then be determined by testing.

Among the minerals which are not soluble either in water or acid may be enumerated sulphur, graphite, cinnabar, some metallic oxides, some sulphates, chromates, and fluorides; but especially silex, and a great number of silicates. These, as well as some other minerals that cannot be distinguished by the blowpipe, must be reduced to an extremely fine powder, melted in four times their weight of anhydrous carbonate of soda, in a platinum crucible, and thereby rendered soluble in hydrochloric acid and water, and their solution examined further.

In some cases, as when the mineral contains soda, it should be decomposed by heating it strongly with five times its weight of carbonate of barytes.

Some mineral aluminates, nearly infusible in carbonate of soda, may be readily decomposed by fusion with a mixture of carbonate and of borate of soda, or with anhydrous bisulphate of potash.

Non-metallic Elements and their Compounds with Oxygen.

Water.—When the assay is heated in a tube closed at one end, the water is driven off, and is deposited at the cool end of the tube.

Nitric Acid.—Nitrates deflagrate on red-hot charcoal, when they are fusible: heated in the closed tube, they yield nitrous acid, which is known by its colour and smell. The latter reaction is more evident when the salt is mingled with copper-filings, and strong sulphuric acid added. A mixture of one part of sulphuric acid and four parts of a solution of a nitrate becomes dark brown around a bit of sulphate of iron placed in it.

Sulphur and sulphurets on charcoal, or in the closed tube, evolve sulphurous acid. Sulphuret of arsenic and of mercury sublime in the closed tube. When some sulphurets, as for example iron pyrites, are heated in the closed tube, part of the sulphur is volatilized. If a very small fragment of any mineral containing sulphuric acid or sulphur be fused with silica and soda, the bead will be coloured yellow or brown by the sulphuret of sodium. A more certain method is to fuse the assay in powder with two parts of soda and one of borax on charcoal in the reducing flame, and then place it in a drop of water on a bright surface of silver, the silver will turn brown or black. According to v. Kobell, sulphuric acid may be distinguished from sulphur in a mineral as follows:—Boil the pulverized mineral in a solution of caustic potash, heating till the potash begins to melt: add water, and filter. A bit of bright silver, placed in the clear solution, will be blackened if the sulphur existed as sulphur and not as sulphuric acid.

Phosphoric acid.—According to Erdmann, most of the combinations of phosphoric acid colour the blowpipe flame green, especially when they have been moistened with sulphuric acid. The experiment must be made in the dark, and succeeds when the mineral contains only three per cent. of phosphoric acid. When the per centage is larger, the assay is melted with boracic acid in the outer flame, a bit of very fine iron wire inserted into the red-hot bead, and the whole exposed to the reducing flame. Phosphuret of iron is formed, which, on breaking the bead after it has cooled, appears as an iron black magnetic globule. This test can be depended on only when no sulphuric or arsenious acid, or metallic oxide, reducible by iron, is present. In solution, phosphoric acid yields a white crystalline precipitate with chloride of magnesium, on adding ammonia, which is soluble in acids but not in sal-ammoniac, and with acetate of lead a precipitate which, when fused before the blowpipe, becomes crystalline on cooling. If molybdate of ammonia be added to a solution containing phosphoric acid, and then hydrochloric or nitric acid in excess, the solution becomes yellow, and in a little time a yellow precipitate is formed.

Selenium and selenic acid are known by their very remarkable smell of rotten horse-radish in the outer flame; by the grey deposit with a metallic lustre which is formed on the charcoal, and by the red sublimate formed when a compound of selenium is roasted in the open tube.

Chlorine and chlorides.—Salt of phosphorus is melted with as much oxide of copper as suffices to make a very dark green bead, with which the assay is fused; the flame then assumes a violet colour till all the chlorine is driven off. When the quantity of chlorine is very small the assay must be dissolved in nitric acid, having previously rendered it soluble if necessary by fusion with soda on platinum wire; the solution, diluted with water, on adding nitrate of silver, yields a precipitate of chloride of silver which becomes dark on exposure to the light, is easily soluble in ammonia, but not at all in nitric acid.

Iodine and iodides, treated in the same manner with salt of phosphorus and oxide of copper, impart to the flame a very beautiful and intense green; and, when heated in the closed tube with bisulphate of potash, they yield violet vapour. In solution iodine gives a precipitate with nitrate of silver, like that of chlorine, which however is soluble with difficulty in ammonia. Strong sulphuric acid being poured on an iodide in a test tube, a strip of starched paper or cotton in the upper part of the tube will be turned blue.

Bromine and bromides, melted in like manner with salt of phosphorus and oxide of copper, impart to the flame a greenish blue. Heated with bisulphate of potash in the closed tube, they yield vapours of bromine, which are recognized by their yellow colour and peculiar smell. When a mineral containing bromine is treated with sulphuric acid in a test tube, a piece of starched paper in the upper part of the tube assumes an orange-yellow colour at the end of a few hours.

Fluorine.—When it is present in small quantities, and not as an essential constituent, if the assay be heated alone in the closed tube, having a strip of Brazil wood paper in its mouth, the glass will be corroded and the paper become yellow. But when the fluorine is in large quantity, and is chemically combined, the assay must be heated with fused salt of phosphorus in the open tube in order to produce the same results. The assay being reduced to powder, mixed with strong sulphuric acid and warmed in a small platinum crucible covered with a plate of glass coated with wax, having lines traced upon it with a wooden point, the places where the glass is laid bare will be found corroded if the mineral contained fluorine.

Boracic acid.—One part of the assay in powder is mixed with three parts of a flux consisting of two parts of fluorspar and nine of bisulphate of potash, and melted; at the instant of melting the flame becomes green. The assay is heated with sulphuric acid and evaporated to dryness; alcohol is then added, and set on fire. The boracic acid, if present, is volatilized with the alcohol, and imparts a decided green colour to the flame.

Carbon in powder heated with nitre deflagrates.—Carbonic acid cannot be detected in the dry way. It is easily discovered by the effervescence which is produced when the assay is treated with hydrochloric acid, heated if necessary. The gas evolved is void of smell. Carbonic acid in solution, on adding lime water or barytes water, yields a precipitate, which effervesces with acids.

Silicic acid alone remains unchanged, is very slowly dissolved in borax, and very slightly in phosphoric salt; in soda, however, it melts with violent effervescence into a clear glass. There are two modifications of silicic acid; one of which, the amorphous, is soluble in water and acids, the other, the crystalline, is acted on only by hydrofluoric acid. The former is readily soluble in boiling solution of potash, the latter with great difficulty. Many silicates can be dissolved in hydrochloric acid, the more readily the stronger the base, the smaller the quantity of silicic acid, and the greater that of water contained in them. The hydrochloric acid either combines with the base, leaving the silica as a jelly or powder, or it dissolves the silica also, which does not gelatinize till the solution is evaporated. But many of the silicates are insoluble in acids, and must be rendered soluble by fusion with carbonate of soda, during which the silica combines with the soda. On evaporating the solution a jelly is formed, and then a dry residue, partly soluble in boiling hydrochloric acid; the remainder is silica.

Alcalis and Earths.

Ammonia is discovered immediately by its smell, when the assay is heated in the closed tube with soda. When an ammoniacal salt is rubbed together with hydrate of lime, or warmed with a solution of potash, the ammonia is also driven off, and is known either by its smell or by its browning turmeric paper, or by the white cloud which is formed when a glass rod, moistened with hydrochloric acid, is held over the assay.

Soda is discovered in a mineral by the reddish yellow colour which it imparts to the outer flame when the assay is strongly heated. Soda yields a precipitate with antimoniate of potash; it gives no precipitate with chloride of platinum or with sulphate of alumina; and with tartaric acid a fine acicular precipitate, only when the solution is very much concentrated.

Lithia, when its quantity is not too small, is discovered by the beautiful carmine red which the assay imparts to the flame while in fusion. When the proportion of lithia is small, the same colouring is exhibited, according to Turner, on melting the assay with two parts of fluorspar and three of bisulphate of potash. This method fails when soda also is present, for then the flame is yellow.

Potash, in the absence of both soda and lithia, is known by the violet colour which appears when the assay is heated in the outer flame. When either soda or lithia are present this test fails; in this case, however, an assay, containing potash melted in a bead of borax coloured brown by oxide of nickel, imparts to it a blue colour. In concentrated solutions of potash salts, bichloride of platinum causes a citron yellow crystalline heavy precipitate of chloride of potassium and platinum; tartaric acid produces a white granular crystalline precipitate of bitartrate of potash, and sulphate of alumina, after the lapse of some time, a precipitate of crystals of alum. When ammonia is present it must first be driven off. Potash and soda occur frequently in silicates. When the mineral is soluble in hydrochloric acid, the silica is to be separated first; alumina and oxide of iron, if present, thrown down by ammonia, and the lime precipitated from the filtered solution by oxalate of ammonia. The filtered fluid is to be evaporated and ignited to expel the ammoniacal salts. The remainder must be dissolved in water, and if lime was present, oxalate of ammonia again added, the solution filtered, evaporated, and ignited, by which the salts of potash and soda are left pure. They may then be distinguished by the means indicated above. When magnesia is present, the ignited salt is to be dissolved in lime water, filtered, the lime precipitated by carbonate or oxalate of ammonia, the solution evaporated and ignited. When the silicate cannot be dissolved in acids, it must be rendered soluble by igniting it strongly with five times its weight of carbonate of barytes. After the separation of the silica, precipitate the barytes by sulphuric acid, and then proceed as before; or, after the separation of silica and alumina, the barytes may be precipitated by carbonate of ammonia.

Barytes.—Carbonate of barytes melts readily into a clear glass, which becomes milk-white on cooling. Sulphate of barytes is with difficulty fusible, but is reduced to sulphide of barium in the inner flame. In combination with silica, barytes cannot be discovered easily in the dry way. In solution, on adding sulphuric acid or a solution of sulphate of lime, barytes yields instantly a fine white precipitate, which is insoluble in acids and alcalis. It gives a colourless crystalline precipitate with hydrofluosilicic acid. A dilute solution of a neutral salt of barytes yields a precipitate on the addition of chromate of strontia.

Strontia.—The carbonate melts only on the thinnest edges forming luminous excrescences. The sulphate melts without much difficulty in the outer flame, and changes into sulphide of strontium in the inner flame, which being dissolved in hydrochloric acid, dried and moistened with alcohol and set on fire, imparts to the flame a beautiful red colour. In other combinations it must be tested for in the moist way. In solution it gives a precipitate with sulphate of lime, but not immediately. Strontia is not precipitated by hydrofluosilicic acid. If barytes and strontia are both present in a mineral, they must be obtained in solution in hydrochloric acid, evaporated, ignited, pulverized, and digested in alcohol, which dissolves chloride of strontium, but leaves chloride of barium undissolved. The solution of chloride of strontium in alcohol burns with a carmine red flame.

Lime occurs in such various combinations that no general rule can be given for detecting it by the blowpipe. Carbonate of lime becomes caustic, and turns moistened turmeric paper brown. Sulphate of lime in the reducing flame becomes sulphide of calcium, which also has an alkaline reaction. Lime in solution is precipitated by sulphuric acid from concentrated solutions only; by oxalic acid and oxalates when very dilute, and not at all by hydrofluosilicic acid. Yet, because barytes and strontia yield a precipitate with oxalic acid, if they occur along with lime, they must be previously separated by sulphate of potash. Chloride of calcium imparts a yellowish-red colour to the flame of alcohol.

Magnesia, in its pure state, as hydrate, carbonate, and some other combinations, may be known by the flesh red colour it assumes after it has been moistened with nitrate of oxide of cobalt, or mixed with oxalate of oxide of cobalt, and ignited. Magnesia is not precipitated either by sulphuric acid, oxalic acid, or hydrofluosilicic acid. With phosphate of soda, on adding ammonia, it affords a white crystalline precipitate of phosphate of magnesia and ammonia.

Alumina alone is quite unalterable before the blowpipe. In many of its combinations it can be detected by the blue colour which it takes, after being moistened with nitrate of oxide of cobalt and ignited. Alumina in solution yields a white voluminous precipitate with caustic potash, which is easily and completely dissolved in excess of potash, and again precipitated by sal-ammoniac. Carbonate of ammonia also produces a precipitate, which it does not redissolve on being added in excess.

Glucine, *yttria*, *zirconia*, and *thoria*, in combination with other substances, are not easily distinguishable before the blowpipe.

Arsenic, Antimony, Bismuth, Mercury.

Arsenic is dissipated on charcoal in vapours having a smell of garlic: it also sublimes in the matrass. Sulphide of arsenic behaves in the same manner. Most of the arsenides on charcoal, in the inner flame, yield a white deposit at a distance from the assay; or, when the proportion of arsenic is large, grey vapours having a smell of garlic. Some arsenides also in the matrass afford a sublimate of metallic arsenic. In the open tube all arsenides yield arsenious acid. Heated with soda on charcoal in the reducing flame, many arseniates emit a smell of arsenic. Some of the earthy arseniates, heated with charcoal powder in the matrass, yield a sublimate of metallic arsenic. Sulphide of arsenic, and many arseniates and arsenites, yield a sublimate of metallic arsenic, when heated in the matrass with six parts of a mixture of equal parts of dry soda and cyanide of potassium. The presence of arsenic, in many of its combinations, can only be shown in the moist way. The assay in powder must be melted in a platinum capsule, with from three to six times its weight of nitre, by which arseniate of potash is formed. The melted mass is digested in water, the solution concentrated, diluted with alcohol, and tartaric acid added till all the potash is precipitated, and the liquid has an acid reaction. The clear portion is decanted and nitrate of silver added, which produces a reddish-brown precipitate when arsenic is present.

Antimony melts easily on charcoal, then sublimes and is surrounded by a white crystalline deposit of oxide of antimony. In the matrass it will not sublime. In the open tube it burns slowly with a white smoke, which is deposited upon the glass in a sublimate which can be driven from place to place. Most minerals in which antimony is combined with sulphur and other metals afford the same reaction. Oxide of antimony melts easily, sublimes, is reduced on charcoal, and imparts to the flame a faint greenish-blue colour. When the oxide or acid of antimony is present, it is sometimes advisable to mix the assay with soda, and to expose it to the inner flame on charcoal, when the characteristic deposit shows itself.

Bismuth melts very easily, sublimes and coats the charcoal with yellow oxide. It does not sublime in the matrass. In the open tube it gives off no vapour, but is surrounded by melted oxide, which appears dark brown when warm and bright yellow when cold. This reaction and the easy reducibility of the oxide permit bismuth to be easily recognized in its combinations. Oxide of bismuth yields a black precipitate with sulphuretted hydrogen, and is precipitated by potash or ammonia, as a white hydrate, which is not dissolved in an excess of the precipitant. A copious addition of water produces a white precipitate of an insoluble basic salt.

Tellurium sublimes on charcoal, and is surrounded by a red-bordered deposit, which disappears in the reducing flame with a blueish-green flame. In the matrass it sublimes in a metallic state. In the open tube it emits dense vapours and forms a white coating, which may be melted into small transparent drops.

Mercury and all compounds of mercury yield a sublimate of metallic mercury, when they are heated in the matrass either alone or with the addition of tin or soda.

Zinc, Tin, Lead, Cadmium.

Zinc.—The assay mixed with soda is exposed to the blowpipe flame on charcoal, by which the zinc is driven off in a metallic state, but is immediately converted into an oxide (with a blueish-green flame where the quantity of zinc is large), which is deposited on the charcoal. While warm the deposit is yellow, when cold it becomes white; moistened with solution of cobalt, and ignited, it becomes green, and cannot be volatilized in the inner flame. On adding caustic potash to a solution of oxide of zinc, a white gelatinous hydrate is precipitated, which is easily dissolved again in excess of potash, and from which it can be precipitated by sulphuretted hydrogen, as white sulphide of zinc.

Tin occurs as an important ingredient only in tin pyrites and tin ore. It may be known by the white deposit of oxide of tin, formed close behind the assay, which cannot be driven off either in the inner or outer flame. Moistened with solution of cobalt, this deposit assumes a blueish-green colour, which is however very different from that of oxide of zinc. This oxide can be reduced by soda.

Lead.—In combination with sulphur and other metals, it is known by the sulphur yellow deposit of oxide of lead which is formed on charcoal in the outer flame. In salts of lead, on heating the assay with soda on charcoal in the reducing flame, the lead is detected as well by the deposit of oxide of lead as by its reduction to a metallic state. Solutions of salts of lead are colourless, and yield a black precipitate with sulphuretted hydrogen. Hydrochloric acid produces a white chloride of lead, which is unchangeable in ammonia, but is soluble in a large quantity of hot water. Sulphuric acid produces a white precipitate; chromate of potash, a yellow precipitate.

Cadmium—Heated on charcoal, with the addition of soda, in the inner flame the charcoal becomes coated with a reddish brown or yellow sublimate.

Manganese, Cobalt, Nickel, Copper.

Manganese.—When the mineral contains manganese, and no other metal capable of colouring the flux, the bead formed by fusing the assay in the oxidating flame with borax, or salt of phosphorus, on platinum wire, assumes a beautiful amethystine colour, which disappears in the inner flame. When other metals are present, the assay in powder is to be melted with two or three parts of soda, on platinum foil; in the outer flame the fused mass takes a blueish-green colour. Protoxide of manganese is thrown down from its solutions by caustic potash or ammonia, as a white hydrate, which, exposed to the air, gradually becomes dark brown, and is insoluble in carbonate of ammonia.

Nickel.—An assay containing nickel, previously roasted, forms with borax a bead which, when hot, is reddish, or violet-brown, and when cold, is yellowish, or dark red; an addition of nitre changes the colour into blue, by which means oxide of nickel may be distinguished from oxide of iron. In the inner flame, the colour disappears, and the bead becomes grey with finely-divided metallic nickel. The appearances with salt of phosphorus are the same, except that the colour vanishes almost entirely when the bead becomes cold. Solutions of salts of oxide of nickel have a bright green colour, and yield, with potash, a bright green precipitate of hydrate of oxide of nickel, which is unchangeable in the air, but is soluble in carbonate of ammonia.

Copper.—The assay containing copper, previously roasted if its appearance is metallic, being fused with borax, or salt of phosphorus, in the inner flame, the bead is opaque, and of a reddish-brown colour, which may be increased by the addition of a little tin. In the outer flame, the bead, while hot, is green, and blue when cold. With soda, metallic copper is obtained. Solutions of salts of oxide of copper are blue or green, and yield a brownish-black precipitate with sulphuretted hydrogen; ammonia produces at first a pale green or blue precipitate, which is soluble in excess of ammonia, and assumes a beautiful blue colour. Ferrocyanide of potassium, even in very dilute solutions, produces a dark reddish-brown precipitate. Iron throws down copper in a metallic state.

Silver, Gold, Platinum, and the Metals which accompany it.

Silver.—On charcoal, silver may be reduced from many of its combinations. Other combinations and sulphides, of which silver is not an essential constituent, may be examined in the following manner:—The assay in powder, mingled with borax and metallic lead, is melted on charcoal, first in the inner flame, and then for some time in the outer flame. The bead of lead containing silver thus obtained, is to be melted on a cupel of bone ashes in the oxidating flame till most of the lead is oxidized. The bead being placed on a fresh cupel, the remaining lead becomes oxidized, and sinks into the cupel, leaving the globule of silver. In some cases, the globule of silver contains copper or gold. Hydrochloric acid throws down silver from its solution in nitric acid, as a white curdy chloride of silver, which, exposed to the light, gradually becomes black, is soluble in ammonia, and may be precipitated from it again by nitric acid, as chloride of silver.

Gold.—From its combinations with tellurium, it may be easily separated on charcoal. If the globule so obtained is white, it contains more silver than gold, and must be digested in a porcelain capsule with hot nitric acid, in which the globule turns black, and the silver is gradually dissolved, provided not more than one-fourth of it is gold. When the quantity of gold is larger, nitro-muriatic acid must be used, which dissolves the gold. A solution of gold in nitro-muriatic acid gives a purple precipitate with a mixture of protochloride and chloride of tin, and a precipitate of metallic gold with sulphate of iron.

Platinum, and the metals which occur with it, cannot be separated from one another by the blowpipe. Only osmiridium is decomposed when it is strongly heated in the matrass with nitre, when osmic acid is evolved, which may be known by its extremely pungent smell. The mixture of which the grains of platinum usually consist, is soluble in hot nitro-muriatic acid, leaving undissolved grains of osmiridium. Platinum is precipitated from the solution by sal-ammoniac, as chloride of platinum and ammonium. Afterwards, the solution being evaporated to dryness, and then diluted, palladium is precipitated as a cyanide by cyanide of mercury. Rhodium is separated by dissolving it in melted bisulphate of potash, which does not dissolve platinum and iridium.

Cerium, Lanthanium, Didymium, Iron, Chrome, Vanadium, Uranium.

Cerium, when it occurs in minerals which contain no other metal capable of giving colour to the fluxes, such as oxide of iron, may be known by the red or dark yellow glass formed by fusing the assay in the outer flame with borax, or salt of phosphorus, the colour of which, in cooling, becomes very pale, and disappears entirely in the inner flame. Oxide of cerium is frequently combined with oxides of lanthanium and didymium, which were confounded with it before the existence of those substances was known.

Lanthanium.—The oxide forms a colourless glass with borax. With salt of phosphorus it forms a colourless bead, which becomes milk-white when the proportion of the oxide is large.

Didymium.—The oxide yields a violet glass with borax in the outer flame, and with salt of phosphorus, a bead having the same amethystine colour as that produced by titanic acid.

Iron.—Its oxide, and the hydrate of the oxide, become black and magnetic before the blowpipe. Minerals containing iron form, with borax in the outer flame, a dark red glass, which, on cooling, becomes bright yellow, and in the inner flame an olive-green, or mountain-green glass, especially when tin is added. Exceptions, however, occur when cobalt, copper, nickel, chrome, or uranium are present. When the iron is combined with sulphur or arsenic, the assay must be previously roasted. Solutions of salts of protoxide of iron are green; from these the protoxide is thrown down by caustic potash, or ammonia, as a hydrate, which at first is white, but soon becomes a dirty green, and at last yellowish brown. Carbonate of lime produces no precipitate. Ferrocyanide of potassium produces a voluminous blueish white precipitate, which turns blue on being exposed to the air. Ferridcyanide of potassium produces a beautiful blue precipitate. The salts of the oxide afford solutions from which the oxide is precipitated by potash or ammonia as a flocky brown hydrate. Carbonate of lime also produces a precipitate. Ferrocyanide of potassium produces a blue precipitate; ferridcyanide of potassium no precipitate.

Chrome.—Most minerals containing chrome, when melted with borax or salt of phosphorus, yield a glass which is yellow, or red, while warm, but emerald green when cold. Usually this reaction shows itself best in the inner flame, but when oxide of lead or of copper is present, in the outer flame. Oxide of chrome may be known by its green colour in solutions. It is precipitated by potash as a blueish green hydrate, soluble in excess of potash. Chrome may be detected in many minerals by fusing the assay with three times its volume of nitre, by which chromate of potash is formed, which may be dissolved in hot water, and, with acetate of lead, gives a yellow precipitate of chromate of lead.

Vanadium, as vanadic acid, melted on platinum wire, with borax, or salt of phosphorus, yields a glass which, in the outer flame, is yellow or brown, and is green in the inner flame. The appearance in the outer flame distinguishes vanadium from chrome.

Uranium.—Most minerals containing uranium, fused with salt of phosphorus in the outer flame, yield a clear yellow glass, and in the inner flame, a beautiful green glass. The reaction with borax is the same as that of iron.

Molybdenum, Tungsten, Tantalum, Pelopium, Niobium, Titanium.

Molybdenum, in the inner flame, with salt of phosphorus, produces a green glass, but with borax, a brown glass.

Tungsten occurs only as tungstic acid, which, in some cases, may be known by its forming, with salt of phosphorus in the outer flame, a colourless, or yellow glass, and in the inner flame a beautiful blue glass, which, as long as it is warm, appears green. When iron is present, however, the glass is blood-red. More generally, tungstic acid may be discovered by melting the assay with five times its weight of soda in a platinum capsule, dissolving in water, filtering, and adding hydrochloric acid, which throws down the tungstic acid. The precipitate is white when cold, and citron yellow when heated.

Tantalum, as tantalic acid, is not readily distinguishable before the blow-pipe: in salt of phosphorus it is soluble readily, and in large quantities, forming a clear glass, which does not become opaque on cooling, and is not turned blue by solution of cobalt. This process serves to distinguish tantalic acid from glucine, yttria, zirconia, and alumina. Its actual recognition may be best effected in the following manner:—The assay is melted with twice its weight of nitre and three times its weight of soda, in a platinum capsule, dissolved in water, filtered, and hydrochloric acid added; the tantalic acid is precipitated as a white powder which does not become yellow when heated.

Pelopic acid forms a colourless glass with borax. With salt of phosphorus it yields a clear colourless glass in the outer flame, and in the inner flame, on charcoal, a clear brown glass inclining sometimes to violet. The glass becomes blood-red on the addition of iron.

Niobic acid with borax in the outer flame forms a colourless glass; in the inner flame a violet glass. With salt of phosphorus it forms a transparent colourless glass in the outer flame, and a violet or blue glass, when the proportion of the acid is not too small, in the inner flame. The glass becomes blood-red on the addition of iron.

Titanium.—In anatase, rutile, brookite, and sphene, the presence of titanic acid is shown by the formation of glass with salt of phosphorus, which is, and remains, colourless in the outer flame, but in the inner flame is yellow, when hot, and, while cooling, becomes first red and then violet. When iron is present, the glass is blood-red, and only becomes violet after the addition of tin. In order to discover oxide of titanium in titanic iron ore, the assay must be dissolved in hydrochloric acid, and the solution boiled with tin, by which it acquires the violet colour of oxide of titanium. Titanic iron-ore shows a blue colour when heated with concentrated sulphuric acid.

For further information respecting the methods of distinguishing the constituents of minerals, the reader is referred to the treatises on the use of the blowpipe by Berzelius and Plattner, the introductions to Analytical Chemistry by Rammelsberg and Fresenius, and H. Rose's 'Ausfürliches Handbuch der Analytischen Chemie.' Methods of discriminating mineral species by simple experiments with the blowpipe and with liquid tests are given in von Kobell's 'Tafeln zur Bestimmung der Mineralien mittelst einfacher chemischer Versuche auf trockenem und nassem Wege.' These tables have been translated into English by Muspratt.

Pseudomorphism.

284. Pseudomorphous minerals are those which have the composition of one mineral and the form of another. Thus steatite is found in the form of quartz, spinelle, idocrase, garnet, tourmaline, topaz, felspar; malachite in the forms of chessylite, towanite, fahlerz, cuprite; serpentine in the form of garnet, mica, spinelle, augite, humite, olivine, amphibole; quartz in the form of baryte, fluor, calcite, dolomite, galena, scheelite, cerussite, hematite, pyrite, chalybite; chalcedony in the form of datholite; mica, and the substances called hard fahlunite, aspasiolite, fahlunite, esmarkite, bonsdorffite, chlorophyllite, weissite, praseolite, pyrargyllite, gigantolite, pinite, in the form of cordierite.

For an account of the probable nature of the processes by which one mineral fills the space previously occupied by another, as one mineral is, without change of form, converted into another, or otherwise altered in its composition, the reader is referred to the Essays of Haidinger, in Poggendorff's 'Annalen.' B. 11, s. 173 and 366. B. 62, s. 161; and especially to Blum's 'Die Pseudomorphosen des Mineralreichs,' and 'Nachtrag zu den Pseudomorphosen des Mineralreichs.' An abstract of the latter has been given by Mr. Dana, in Silliman's Journal for 1845, vol. xlviii., p. 66; and 1848, new series, vol. vi., p. 267.

List of Pseudomorphous Minerals from Blum's 'Die Pseudomorphosen des Mineralreichs' and 'Nachtrag.'

Pseudomorphous by Loss of an Ingredient.

Calcite	in the form of	Gaylussite.
Quartz	,,	Heulandite.
Quartz	,,	Stilbite.
Kyanite	,,	Andalusite.
Steatite	,,	Amphibole.
Copper	,,	Cuprite.
Argentite	,,	Pyrargyrite.

Pseudomorphous by the Addition of an Ingredient.

Gypsum	in the form of	Karsteinite.
Mica	,,	Pinite.
Valentinite	,,	Antimony.
Anglesite	,,	Galena.
Hematite	,,	Magnetite.
Limonite	,,	Hematite.
Malachite	,,	Cuprite.
Bornite	,,	Redruthite.
Towanite	,,	Redruthite.

Pseudomorphous by Exchange of Ingredients.

Baryte	in the form of	Witherite.
Baryte	,,	Barytocalcite.
Fluor	,,	Calcite.
Gypsum	,,	Calcite.
Calcite	,,	Gypsum.
Magnesite	,,	Calcite.
Chalcedony	,,	Datholite.
Jasper	,,	Amphibole.
Opal	,,	Augite.
Cimolite	,,	Augite.
Lithomarge	,,	Topaz.
Lithomarge	,,	Felspar.
Lithomarge	,,	Nepheline.
Kaolin	,,	Felspar.
Kaolin	,,	Porzellanspath.
Kaolin	,,	Leucite.
Mica	,,	Andalusite.
Mica	,,	Felspar.
Mica	,,	Scapolite.
Mica	,,	Tourmaline.

Mica	in the form of	Cordierite.
Hard fahlunite	,,	Cordierite.
Aspasiolite	,,	Cordierite.
Fahlunite	,,	Cordierite.
Esmarkite	,,	Cordierite.
Bonsdorffite	,,	Cordierite.
Chlorophyllite	,,	Cordierite.
Weissite	,,	Cordierite.
Praseolite	,,	Cordierite.
Pyrargillite	,,	Cordierite.
Gigantolite	,,	Cordierite.
Pinite	,,	Cordierite.
Prehnite	,,	Analcime.
Prehnite	,,	Mesotype.
Prehnite	,,	Leonhardite.
Talc	,,	Chiastolite.
Talc	,,	Kyanite.
Talc	,,	Couzeranite.
Talc	,,	Felspar.
Talc	,,	Pyrope.
Steatite	,,	Magnesite.
Steatite	,,	Spinelle.
Steatite	,,	Quartz.
Steatite	,,	Andalusite.
Steatite	,,	Chiastolite.
Steatite	,,	Topaz.
Steatite	,,	Felspar.
Steatite	,,	Mica.
Steatite	,,	Scapolite.
Steatite	,,	Tourmaline.
Steatite	,,	Staurolite.
Steatite	,,	Garnet.
Steatite	,,	Idocrase.
Steatite	,,	Augite.
Serpentine	,,	Spinelle.
Serpentine	,,	Mica.
Serpentine	,,	Garnet.
Serpentine	,,	Augite.
Serpentine	,,	Chondrodite.
Serpentine	,,	Amphibole.
Serpentine	,,	Olivine.
Amphibole	,,	Augite.
Chlorite	,,	Felspar.
Chlorite	,,	Garnet.
Chlorite	,,	Amphibole.
Pyrolusite	,,	Manganite.
Hausmannite	,,	Manganite.

Valentinite	in the form of	Antimonite.
Stibiolite	„	Antimonite.
Kermes	„	Antimonite.
Wismuthocker	„	Patrinite.
Minium	„	Galena.
Minium	„	Cerussite.
Galena	„	Pyromorphite.
Pyromorphite	„	Galena.
Pyromorphite	„	Cerussite.
Cerussite	„	Galena.
Cerussite	„	Anglesite.
Cerussite	„	Leadhillite.
Wulfenite	„	Galena.
Magnetite	„	Chalybite.
Hematite	„	Göthite.
Hematite	„	Pyrite.
Hematite	„	Pharmacosiderte.
Hematite	„	Chalybite.
Limonite	„	Marcasite.
Stilpnosiderite	„	Vivianite.
Limonite	„	Skorodite.
Limonite	„	Chalybite.
Pyrite	„	Mispickel.
Melanterite	„	Pyrite.
Grünerde	„	Augite.
Pseudotriplite	„	Triphyline.
Wolfram	„	Scheelite.
Erythrine	„	Smaltite.
Kupferschwärze	„	Redruthite.
Kupferpecherz	„	Towanite.
Kupferpecherz	„	Fahlerz.
Covelline	„	Towanite.
Malachite	„	Chessylite.
Malachite	„	Towanite.
Malachite	„	Fahlerz.
Chessylite	„	Fahlerz.

Pseudomorphous by total change of substance.

Graphite	in the form of	Pyrite.
Salt	„	Magnesite.
Karstenite	„	Salt.
Gypsum	„	Salt.
Polyhalite	„	Salt.
Quartz	„	Baryte.
Quartz	„	Fluor.

Quartz	in the form of	Gypsum.
Quartz	,,	Calcite.
Quartz	,,	Barytocalcite.
Quartz	,,	Magnesite.
Quartz	,,	Scheelite.
Quartz	,,	Galena.
Quartz	,,	Cerussite.
Quartz	,,	Hematite.
Quartz	,,	Pyrite.
Quartz	,,	Chalybite.
Prasem	,,	Calcite.
Eisenkiesel	,,	Calcite.
Chalcedony	,,	Baryte.
Chalcedony	,,	Fluor.
Chalcedony	,,	Calcite.
Chalcedony	,,	Magnesite.
Chalcedony	,,	Pyromorphite.
Carnelian	,,	Calcite.
Hornstone	,,	Fluor.
Hornstone	,,	Calcite.
Hornstone	,,	Mica.
Hornstone	,,	Chalybite.
Semiopal	,,	Calcite.
Lithomarge	,,	Fluor.
Pyrite	,,	Quartz.
Pyrite	,,	Stephanite.
Pyrite	,,	Pyrargyrite.
Marcasite	,,	Pyrargyrite.
Chalybite	,,	Baryte.
Chalybite	,,	Calcite.
Chalybite	,,	Magnesite.
Malachite	,,	Calcite.
Malachite	,,	Cerussite.
Crysocolla	,,	Cerussite.
Feldstein	,,	Calcite.
Meerschaum	,,	Calcite.
Pyrolusite	,,	Calcite.
Pyrolusite	,,	Magnesite.
Hausmannite	,,	Calcite.
Manganite	,,	Calcite.
Psilomelane	,,	Baryte.
Psilomelane	,,	Fluor.
Psilomelane	,,	Pharmacosiderite.
Smithsonite	,,	Fluor.
Smithsonite	,,	Calcite.
Smithsonite	,,	Magnesite.
Smithsonite	,,	Galena.

Smithsonite	in the form of	Pyromorphite.
Kassiterite	,,	Felspar.
Cerussite	,,	Baryte.
Cerussite	,,	Fluor.
Stilpnosiderite	,,	Magnesite.
Stilpnosiderite	,,	Calamine.
Hematite	,,	Fluor.
Hematite	,,	Calcite.
Limonite	,,	Baryte.
Limonite	,,	Fluor.
Limonite	,,	Calcite.
Limonite	,,	Magnesite.
Limonite	,,	Quartz.
Limonite	,,	Comptonite.
Limonite	,,	Blende.
Limonite	,,	Galena.
Limonite	,,	Pyromorphite.
Limonite	,,	Cerussite.
Limonite	,,	Cuprite.
Pyrite	,,	Baryte.
Marcasite	,,	Fluor.
Pyrite	,,	Calcite.
Marcasite	,,	Calcite.

Pseudomorphism of Dimorphous Substances.

Calcite	in the form of	Aragonite.
Marcasite	,,	Pyrite.

After Organic Forms.

Calcite.
Baryte.
Celestine.
Fluor.
Gypsum.
Quartz.
Opal.
Talc.
Pyrite.
Hematite.
Limonite.
Chalybite.
Blende.
Galena.
Cerussite.
Copper.
Towanite.
Bornite.
Redruthite.
Cinnabar.

The order in which the characters will be given in the following descriptions of minerals :—

The system of crystallization to which the mineral belongs.

The angular elements used in computing the mutual inclinations of the faces of the crystal.

The letters and symbols by which the simple forms are denoted.

Enumeration of hemihedral forms.

The angles between normals to the faces. These angles are the supplements of the angles between the faces as they are usually given. It happens not unfrequently that forms occur, the faces of which could not be shown in the figures, without increasing their number enormously, and that the situation of such faces is not capable of being clearly described in words. In every case of this kind we have added a map of a sphere to the surface of which the faces of the crystal are referred, by radii drawn perpendicular to the respective faces. This sphere is called the sphere of projection, and the extremity of a radius drawn perpendicular to any face is called the pole of that face. The map for crystals belonging to the cubic system is given in fig. 28. As the dots on the maps, corresponding to the faces on the figures, are marked by corresponding indices or letters, the reader will, after a little practice, be able easily to perceive the relation of the maps to the figures, and, when once accustomed to observe the crystalline forms on the maps, he will experience as little difficulty in tracing the relative positions of the faces as on the solid figures he has been accustomed to consult. The maps given in this work exhibit, respectively, all the faces which we are aware of having been hitherto observed on the crystals of each separate mineral, and, being records of all that is at present known of crystalline forms, they may for a long time be consulted by the mineralogist as standard figures.

Simple forms that have been observed in nature without any additional faces, and the principal combinations of simple forms which have been observed. The lists of combinations are sometimes abbreviated. Thus *enpr.d.z.t* is used to denote combinations of the forms *e*, *n*, *p*, *r* with each of the forms *d*, *z*, *t*; and *enpr..d.z.t* to denote that the forms *e*, *n*, *p*, *r* have been observed in combination with each and with all of the forms *d*, *z*, *t*. The letters denoting hemihedral forms have accents placed over them. When two or more hemihedral forms have their poles in the same subdivisions of the sphere of projection, the accents annexed to the corresponding letters incline the same way; when they are in different subdivisions, the accents incline different ways.

Twin crystals. Twin-plane, or axis.

The faces parallel to which cleavages exist.

The nature of the fractured surface.

The degree of transparency of the mineral.

Lustre.

Index of refraction of crystals belonging to the cubic system. Optical constants of crystals belonging to the other systems. In uniaxal crystals μ denotes the index of refraction of the ordinary ray; μ' the index of refraction of the extraordinary ray in a plane perpendicular to the optic axis. An approximate value of the refractive power of a doubly refractive crystal is denoted by R.

Colour and pleochromatism.

Colour of the streak or powder of the mineral.

Whether fragile or tough, flexible or elastic.

Hardness, denoted by H.

Specific gravity, denoted by G.

Magnetism.

Electrical properties.

Taste and odour.

Chemical characters.

Chemical formula, and composition computed from the formula.

Selected analyses.

Modes of occurrence.

Principal localities.

Observations.

DESCRIPTIONS OF SPECIES.

METALLOIDS.

1. **SULPHUR.**—Sulphur; Phillips. Soufre; Hauy. Prismatischer Schwefel; Mohs. Schwefel; Hausmann, Haidinger.

Prismatic. $011,010 = 23^\circ\ 7'{\cdot}5$; $101,001 = 62^\circ\ 12'$; $110,100 = 50^\circ\ 59'$.

b 010, *c* 001, *e* 011, *u* 013, *n* 101, *w* 203, *v* 103, *m* 110, *k* 210, *p* 111, *y* 112, *s* 113, *t* 115, *x* 313, *z* 315.

uc	37°	58′	mc	90°	0′	tt'	37°	56′
ec	66	53	pe	36	41	tt''	46	58
bc	90	0	pb	42	29	$t't''$	62	9
uu'	75	56	xb	70	0	sb	56	36
ee'	133	45	nb	90	0	ss'	52	29
vc	32	18	pp'	73	22	ss''	66	49
wc	51	40	pp''	95	2	$s's''$	90	15
nc	62	12	$p'p''$	143	17	zc	50	54
nn'	124	24	tb	66	31	xc	64	0
kb	58	19						
mb	39	1						
mm'	78	2						
tc	31	5						
sc	45	8						
yc	56	26						
pc	71	39						

FIG. 82.

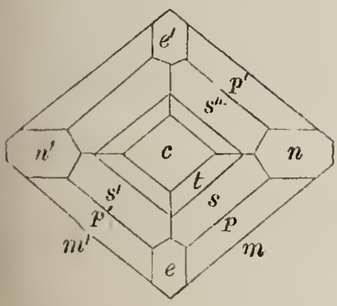
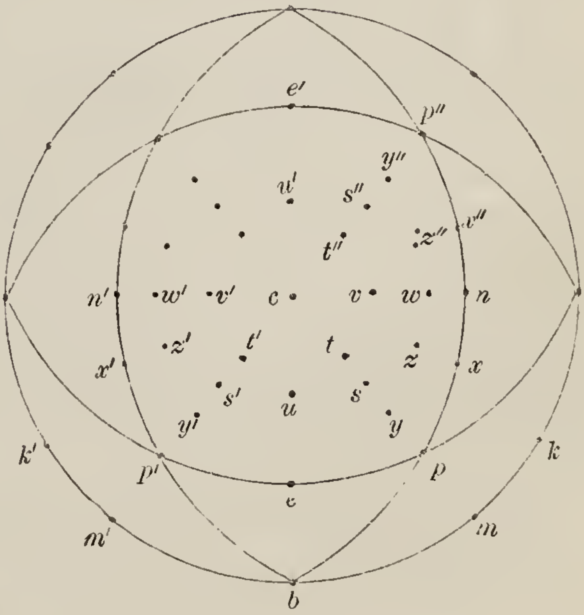


FIG. 83.



Forms and combinations. *p, cp, pm, npb, csnpm..te.btyvwkxz.* The faces *n* usually rough; the other faces smooth and bright. Twins. Twin-face *m.* Cleavage. *p, m,* imperfect. Fracture conchoidal...uneven. Transparent...translucent on the edges. Lustre resinous, inclining to adamantine. R = 2·0...2·24. Sulphur-yellow, passing into red, brown, grey. Streak, sulphur-yellow...white. Sectile. H = 1·5...2·5. G = 2·0....2·1 Acquires resinous electricity by friction.

Sublimes in the matrass. Melts at 111° C; boils at 420° C; in the open air takes fire at 270° C, and burns with a blue flame, forming sulphurous acid.

S, sulphur.

Some varieties contain selenium, which imparts to them an orange-yellow colour; others are coloured brown by bitumen.

In attached crystals and druses; globular, reniform, and stalactitic masses, disseminated.

Is found in mica slate at Ticsan in Quito, and Glashütte in Hungary. In limestone at Carrara. In metallic veins at Riepoldsau in the Black Forest, in Siegen, and at Bries in Hungary. In beds of gypsum at Girgenti, Cataldo, Fiume, and other places in Sicily, Urbino, Modena, and Tuscany; at Conil near Cadiz; in Murcia and Aragon; at Czarkow and Swoszowice near Cracow, Bex, Radoboy near Crapnia in Croatia, Lauenstein in Hanover. In sandstone in Greenland, Roisdorf on the Rhine, Occhio in Sicily, and Siena in Italy. In alluvium at Aosta. In brown coal at Artern in Thuringia. As a volcanic sublimate in the Solfatara near Naples, the Lipari Islands, Ætna, Iceland, Guadaloupe, Java, Teneriffe, Bourbon, the volcanoes of the Pacific Ocean. As a deposit from the hot springs of Aix-la-Chapelle, Nenndorf, Eilsen. The finest crystals are found at Conil, at Forli near Naples, and in Sicily.

The faces *u, w, v, y, x, z, k,* were observed in a group of crystals in Mr. Brooke's collection.

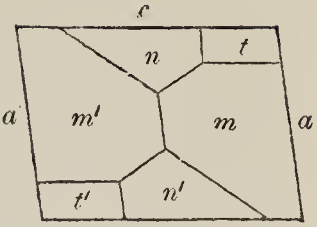
Crystals of sulphur obtained by sublimation, by the slow evaporation of a solution of sulphur in bisulphide of carbon, and, in some cases, by the cooling of sulphur from the lowest temperature of fusion, have the form described above. The crystals formed by the cooling of sulphur, heated considerably above the melting point, and, according to Pasteur, sometimes, though rarely, when crystallized from bisulphide of carbon, belong to the oblique system.

101,100 = 40° 0′; 111,010 = 56° 12′; 101,001 = 42° 14′.

a 100, *c* 001, *n* 011, *m* 110, *t* 111.

ca	84°	14′	*tc*	52°	2′
mm′	90	32	*mt*	33	53
ma	44	14	*nc*	44	51
nn′	90	18	*mc*	85	55

FIG. 84.



Twins. Twin-face *a*. Cleavage. *c*, *m*. The crystals are at first transparent, but after exposure to the air become opaque.

2. SELENIUM.—Selen; Hausmann, Haidinger.

Brownish-black...lead-grey. In thin plates, red by transmitted light. H = 2·0. G = 4·3.

Sublimes in the matrass. Melts at a little above 100° C; boils at 700° C.

Se, selenium.

Is found investing sulphur in Sicily.

3. DIAMOND.—Diamond; Phillips. Diamant; Hauy. Oktaedrischer Demant; Mohs. Demant; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *g* 032, *i* 043, *p* 122, *s* 321. The forms *o*, *p*, *s*, are frequently hemihedral with inclined faces.

aa′	90°	0′	*ga′*	33°	41′	*pa*	70°	32′
oo′	70	32	*go*	36	49	*po*	15	48
oa	54	44	*ii′*	16	16	*pd*	19	28
dd′	60	0	*ia′*	36	52	*sa*	36	42
da′	45	0	*pp′*	27	16	*so*	22	13
do	35	16	*pp,*	38	57			

FIG. 85.

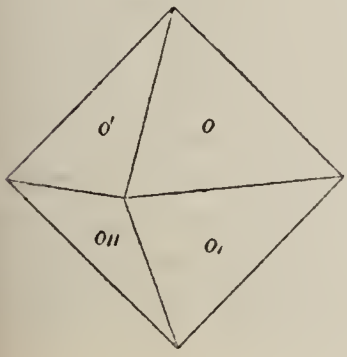


FIG. 86.

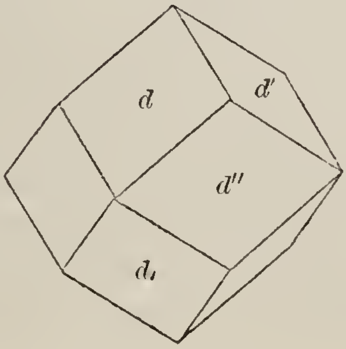


FIG. 87.

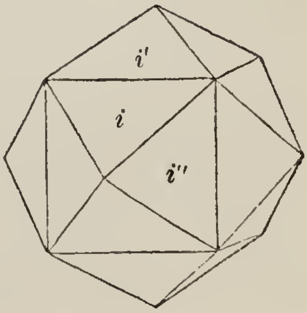


FIG. 88.

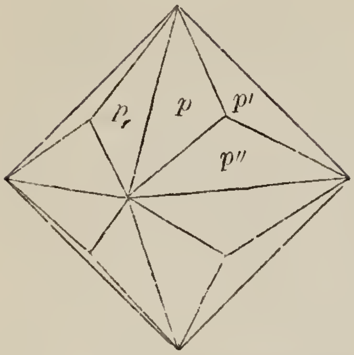


FIG. 89.

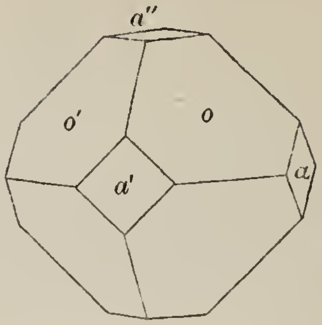
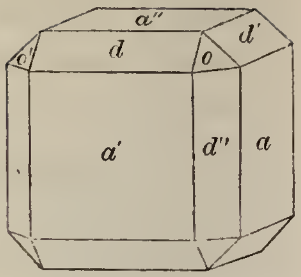


FIG. 90.



Forms and combinations. *o, d, i, p, s, ao, ad, od, ai, oi, si, os, o's', aod, aoi, ois, do's', aodpi.* The faces *d* sometimes rough and curved; *g, i, p, s* curved. Twins. Twin-face *o*. The twin-crystals are frequently hemihedral, and very thin in the direction of a normal to the twin-face. Cleavage. *o*, very perfect. Fracture conchoidal. Transparent...translucent. Lustre adamantine. $\mu = 2{\cdot}44$. Colourless, white, grey, brown, green, yellow, red, blue, rarely black. Streak grey. H = 10·0. G = 3·5...3·6. Acquires vitreous electricity by friction. Does not conduct electricity. Some varieties are phosphorescent for some time after exposure to the light of the sun.

Burns away before the blowpipe on platinum foil. When burnt in an atmosphere of oxygen, the product of combustion is carbonic acid. Is not acted upon by acids.

C, carbon.

In isolated and imbedded crystals and grains, rarely massive.

Is found in a quartz conglomerate, in strata of clay and sand containing iron oxide, and in alluvium, on the eastern boundary of the plateau of the Deccan, between the parallels of 14° and 25°. The principal localities are,—on the river Pennar between Cuddapah and Gandicotta; between the Pennar and Kistna near Nandial; on the lower Kistna near Ellore; Sumbhulpur on the Mahanadi; Pannah between the rivers Sonar and Sone in the Bundelkund. Diamonds are also found in Malacca; on the west side of the Ratu mountains, rather to the north of Pulo Ari, Landak, Sekajam and Tajan in Borneo, in Celebes and Java. They are found in the Brazils in alluvium, accompanied by oxides of iron, quartz, kyanite, beryl, chrysoberyl, anatase, topaz, spinelle, corundum, garnet, &c.; in the district of Cero do Frio in Minas Geraes, in the beds of Rio Jequitinhonha and Rio Arassuhay; on the right bank of the Rio S. Francisco at Matto Grosso, and in the beds of Rio Pardo, Rio Velhas, and various other rivers, all of which fall into the S. Francisco; in the mines of Riven and Cuithé;

in the Serra do S. Antonio, Serra das Arraras, and in the brook Capivary and the river Parannan in the Capitania of Goyaz; in the Rio Tibagy in the district of S. Paulo, and in some of the tributaries of the Rio Doce; on the banks of the Cachoina. Recently diamonds have been found imbedded in itacolumite, a micaceous sandstone, on the left bank of the Corrego dos Rois; on the Serra de Grammagoa, about 170 English miles north of Tijuco, and at Canga de Riberao das Datas, twenty-three miles from Tijuco. According to Eschwege, itacolumite is the prevailing rock in the Serra de Antonio, in which the Jequetinhonha rises in the Serra da Matta da Corda, on the eastern slope of which the tributaries of the Rio Francisco rise, and in the diamond district of Tibagy. A black massive variety has been very lately found in the Serra Madre, in Mexico. Small diamonds have been found, in no great number, in the gold stream-works in the Ural, on the banks of the Poludennaja and Adolfskoi, tributaries of the Koiwa, not far from Bissersk; at Kuschaisk, about seventeen English miles from Kuschwinsk; at Medscher's stream-works, about ten miles to the east of Katharinenburg; and at Verch-Uralsk. A few have been found in Rutherford County in North Carolina, and in Hall County in Georgia.

It appears that the form *d* is most frequently observed in the Brazilian diamonds, and the form *o* in those from the East Indies. According to Parrot, diamonds from the Ural usually show the form *i*. On account of the curvature of the faces *g*, *i*, *p*, *s*, their indices have not hitherto been determined with certainty.

The largest diamonds have been found in the East. The Koh-i-noor is said to weigh 279·56 carats. It is of the form and size of half a hen's egg. The diamond of the Raja of Matun in Borneo is said to weigh 376 carats. The Pitt diamond, one of the Crown jewels of France, found in the Golconda district, weighed uncut 410, in its present state, 136 carats. Petzhold mentions another diamond belonging to the French Treasury weighing 106 carats. The Sancy weighs 33·75 carats. The Emperor of Russia has one of 194·75, and another of 86 carats. The Florentine diamond, the property of the Emperor of Austria, weighs 139·5 carats. According to Petzhold a diamond in the Portuguese Treasury weighs 205 carats. The largest Brazilian diamond, an octahedron, was found in the river Abaité. Its weight is variously stated at from 95 to 138·5 carats. The Nassac diamond, the property of the East India Company, weighs 89·75 carats. A green diamond, preserved in the Grüne Gewölbe at Dresden, weighs 48 carats. One carat = 3·17 grains.

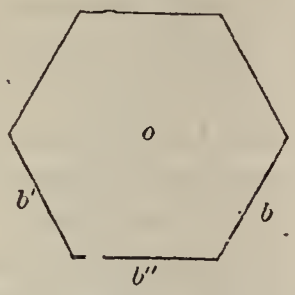
4. GRAPHITE.—Graphite; Phillips, Hauy. Rhomboedrischer Melan-Graphit; Mohs. Graphit; Hausmann, Haidinger.

Rhombohedral.

o 111, *b* $2\bar{1}\bar{1}$.

bo	90° 0′
bb″	60 0

FIG. 91.



Combination. *ob*. The faces *o* striated parallel to their intersections with the alternate faces *b*. Cleavage. *o*, very perfect. Fracture uneven. Opaque. Lustre metallic. Iron-black...dark steel-grey. Streak-black, shining. Sectile. In thin leaves flexible. H = 1·0...2·0. G = 1·8...2·1.

Infusible before the blowpipe, but burns with difficulty. Insoluble in acids, which act only upon the iron and other impurities.

C, carbon, mixed with a variable quantity of iron, amounting in some instances to ten per cent., which may be extracted by digestion in acids; and also sometimes with very small quantities of silica, alumina, lime, and oxides of titanium and copper.

It occurs very rarely crystallized, usually in reniform masses, in flattened grains or scales.

It is found at Arendal in Norway; Göpfersgrün and Wunsiedel in Bavaria; Helette, Mont Labourd and Ursovia in the Pyrenees; Finland, Greenland, North America; in gneiss at Hafnerzell and Griesbach near Passau; in beds near Schottwien and Spitz in Austria; near Freienstein in Styria; at Schwarzbach, Stubu, Swogownov, Naketen-Dörfklas, Tepel and other places in Bohemia; Goldenstein in Moravia; Freiwaldau in Silesia; at Borrowdale in Cumberland in trap; in irregular masses with garnet in gneiss at Strathferran near Beuly in Aberdeenshire and at Kilkenny in Ireland; at Craigman in Ayrshire in the coal formation; at Marbella in the south of Spain; in Ceylon, the Brazils, Sturbridge in Massachusetts, Ticonderoga and several other places in the United States.

METALS.

5. BISMUTH. — Native Bismuth; Phillips. Bismuth natif; Hauy. Oktaedrisches Wismuth; Mohs. Wismuth; Hausmann, Haidinger.

Rhombohedral. 100,111 = 56° 24′

o 111 cleavage, *e* 011 cleavage, *r* 100, *s* $\bar{1}11$ cleavage. *e* truncates the edge *r′r″*.

eo	36°	58′
ro	56	24
so	71	37
rr′	92	20
ss′	110	32
sr′	55	16

FIG. 92.

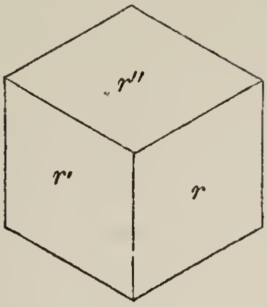
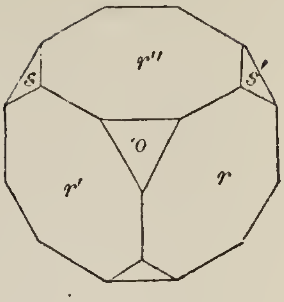


FIG. 93.



Combinations. *os*, *oes*. Crystallizes from fusion in the form *r*. Cleavage. *o*, perfect; *e*, *s*, less perfect. Twins. Twin-face *e*. Opaque. Lustre metallic. Silver white, inclining to red; liable to tarnish. Streak the same. Sectile, almost malleable. H = 2·0…2·5. G = 9·6…9·8.

Melts at 264° c, frequently with a smell of arsenic. After prolonged exposure to the blowpipe flame, deposits a sublimate of oxide on the charcoal, which is yellowish-brown while hot. Soluble in nitric acid. A white precipitate falls when a large quantity of water is added to the solution.

Bi, bismuth, frequently with an admixture of arsenic, amounting in some cases to upwards of 30 per cent.

In crystals and groups of crystals, dendritic, mossy, granular, compact and disseminated.

Occurs in veins of cobalt and silver ores, in granite, gneiss, mica slate, and transition rocks, with smaltine, kupfernickel, and silver, and in tin veins. Is found at Schneeberg, Annaberg, Marienberg, Johann-Georgenstadt and Altenberg in Saxony, Bieber in Hanau, Friedrichrode in Thuringia, Schlackenwald in Bohemia, Löling in Carinthia, Modum in Norway, Fahlun and other parts of Sweden, the Pyrenees, Connecticut, at Redruth and near St. Ives in Cornwall. It was formerly found at Wittichen in Baden and near Hasserode in the Harz.

Bismuth is feebly repelled by either pole of a magnet. A bar of bismuth suspended freely between the poles of a horse-shoe magnet rests in a position at right angles to the line joining the poles of the magnet. When a crystal of bismuth is suspended between the poles of a horse-shoe magnet, the principal cleavage plane *o*, tends to place itself at right angles to the line joining the poles. Also when bismuth crystallizes from fusion between the poles of a powerful magnet, most of the crystals have their principal cleavages perpendicular to the line joining the poles.

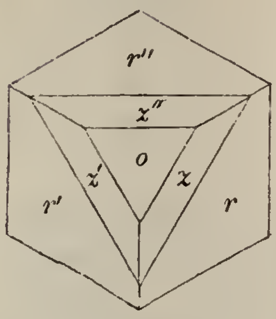
6. ANTIMONY.—Native antimony; Phillips. Antimoine Natif: Hauy. Rhomboedrischer Antimon; Mohs. Antimon; Hausmann, Haidinger.

Rhombohedral. 100,111 = 56° 28′.

o 111, *z* 211, *e* 011 cleavage, *r* 100, *s* $\bar{1}11$ cleavage, *a* $01\bar{1}$ cleavage.

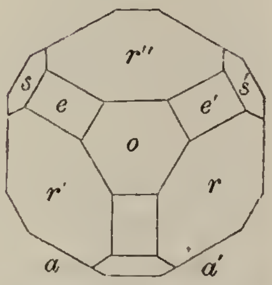
ao	90°	0′	*ee′*	62°	53′
aa′	60	0	*rr′*	92	25
zo	20	40	*ss′*	110	35
ro	56	28	*ze′*	17	48
eo	37	2	*re′*	46	13
so	71	40	*rs′*	55	18
zz′	35	36	*ra′*	43	47

FIG. 94.



Combination. *ozr*. Crystallizes from fusion in the form *r*. The faces *z* striated parallel to their intersections with *r*. Twins. Twin-face *e*. Cleavage. *o*, very perfect; *e*, distinct; the cleavages *o*, *e* striated parallel to their intersections with each other; *s* less distinct; *a* traces. Opaque. Lustre metallic. Tin-white. Streak the same. Rather brittle. H = 3·0...3·5. G = 6·6...6·7. Conducts electricity.

FIG. 95.



In the open tube yields a white sublimate. Melts at 425° C. On charcoal burns and is volatilized, depositing a white sublimate of antimonious acid upon the charcoal.

Sb, antimony.

Analysis of antimony from Andreasberg by Klaproth.

Antimony	98·00
Silver	1·00
Iron	0·25

The curved lamellar varieties, of a tin-white colour inclining to lead-grey, appear to contain arsenic in all proportions from two up to sixty-two per cent. Before the blowpipe they emit fumes of arsenic.

Is seldom crystallized; usually in crystalline granular masses, reniform, disseminated.

Occurs in veins in crystalline rocks with arsenic, antimonite, kermes, antimonsilber, pyrargyrite, proustite, galena. Has been found at Sahlberg near Sahla in Sweden, Allemont in Dauphiné, Przibram in Bohemia, Andreasberg in the Harz.

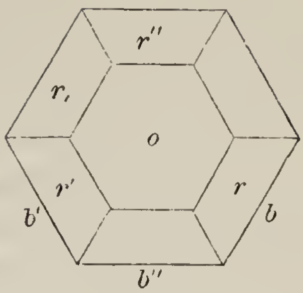
7. TELLURIUM.—Native tellurium; Phillips. Tellure natif; Hauy. Rhomboedrisches Tellur; Mohs. Tellur; Hausmann, Haidinger.

Rhombohedral. 100,111 = 57° 36′.

o 111, *b* $2\bar{1}\bar{1}$, *r* 100, $r_{,}$ $\bar{1}22$.

bo	90°	0′
bb''	60	0
ro	57	36
rb	32	24
rr'	93	58
$r'r_{,}$	49	56
$rr_{,}$	115	12

FIG. 96.



Combination. $obrr_{,}$. Crystallizes from fusion in the form r. Cleavage. o, imperfect; b, very distinct. Opaque. Lustre metallic. Tin-white. Streak the same. Rather sectile. H = 2·0...2·5. G = 6·1...6·3.

In the open tube burns with a greenish-blue flame, and emits a dense smoke. The grey sublimate in the tube becomes white when heated, and melts into transparent drops of tellurous acid. Before the blowpipe on charcoal melts, and is dissipated in a dense smoke, and with a greenish flame. Soluble in nitric acid with evolution of nitrous acid. The solution in concentrated sulphuric acid is red.

Te, tellurium.

According to Klaproth and Petz, consists of

Tellurium	91·55	97·21
Gold	0·25	2·79
Iron	7·20	trace.
Sulphur	—	trace.

In attached crystals, massive, granular, and disseminated. Is found in a sandstone rock, with quartz, gold, and pyrites, in the mine of Maria Loretto at Facebay near Salathna in Transylvania.

According to G. Rose. $ro = 56° 55'$.

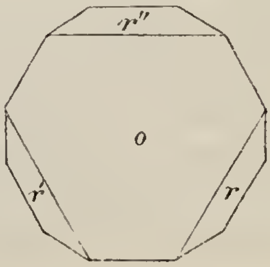
8. ARSENIC.—Native arsenic; Phillips. Arsenic natif; Hauy. Rhomboedrisches arsenik; Mohs. Arsenik; Hausmann, Haidinger.

Rhombohedral. 100,111 = 57° 51′.

o 111, e 011 cleavage, r 100, h $\bar{4}55$. e, h truncate the edge in which o meets the face parallel to r.

eo	38°	30′
ro	57	51
ho	67	16
ee'	65	16
rr'	94	19
hh'	106	2

FIG. 97.



Crystals obtained by sublimation show the combinations *or*, *orh*. Twins. Twin-face *e*. Cleavage. *o*, perfect; *e*, imperfect, striated. Fracture uneven. Opaque. Lustre metallic. Tin-white, inclining to lead-grey. Streak the same. Exposed to the air, becomes greyish-black. Brittle. H = 3·5. G = 5·7...5·8. Conducts electricity perfectly.

Sublimes in the matrass. Is volatilized without melting before the blowpipe, emitting an odour of garlic, and depositing a white sublimate on the charcoal. In nitric acid is converted into arsenious acid.

As, arsenic.

In arsenic from Joachimsthal John found from two to three per cent. of antimony, and one per cent. of red oxide of iron and water.

Seldom crystallized, usually in fibrous, globular, and reniform masses; disseminated.

Occurs usually in veins, seldom in beds, principally in crystalline slate-rocks, accompanied by antimony, antimonial silver, argentite, proustite, galena. Is found at Andreasberg in the Harz, Annaberg, Schneeberg, Marienberg, Freiberg in Saxony, Wittichen in Baden, Joachimsthal in Bohemia, Kapnik in Transylvania, Orawitza in the Banat, Allemont in Dauphiné, Markirchen in Alsace, Kongsberg in Norway.

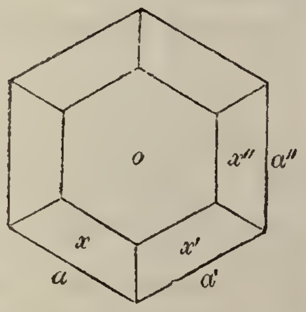
9. OSMIRIDIUM.—Alloy of iridium and osmium; Phillips. Iridosmine; Beudant. Rhomboedrisches Iridium; Mohs. Iridosmium; Hausmann, Haidinger.

Rhombohedral. 100,111 = 58° 27′.

o 111, a $01\bar{1}$, x $13\bar{1}$.

ao	90°	0′
aa′	60	0
xo	62	0
xx′	52	24
xx″	99	45

FIG. 98.



Combinations. *oa*, *oax*. The faces *o* smooth and bright; *x*, *a* dull. Cleavage. *o*, tolerably perfect, yet difficult to obtain. Fracture uneven. Opaque. Lustre metallic. Tin-white, lead-grey. Slightly malleable, but soon cracks under the hammer, and may be reduced to powder. H = 7·0. G = 19·3...21·2.

Ignited with nitre in the matrass, emits the peculiar smell of osmium. Is not sensibly acted upon by acids.

One variety (Sisserskit; Haidinger. Dunkles Osmium-Iridium; G. Rose) is lead-grey. G = 21·118. Before the blowpipe on charcoal turns black and smells strongly of osmium. Causes the flame of a spirit-lamp to burn brightly with a yellowish-red flame. Another variety (Newjanskit; Haidinger. Lichtes Osmium-Iridium; G. Rose) is tin-white. Streak the same. G = 19·386…19·471. Before the blowpipe unchanged. They have both the same form and angles.

Analyses *a*, *b* of the lead-grey, *c* of the tin-white variety from the neighbourhood of Katharinenburg, by Berzelius:—

	a	*b*	*c*
Iridium . .	24·83	19·86	46·77
Rhodium . .	—	—	3·15
Iron . . .	—	—	0·74
Osmium . .	75·17	80·14	49·34
Palladium .	—	—	trace.

These analyses are represented by the formulæ $IrOs^3$, $IrOs^4$, $IrOs$ respectively.

Occurs in small isolated crystals and grains.

The lead-grey variety is found at Nischne Tagilsk, the neighbourhood of Katharinenburg, Sissersk, and Kyschtimsk in the Ural. The tin-white variety, with gold and platinum, in the Ural, in the stream-works at Bilimbajewsk and Werch-Issetsk near Katharinenburg and at Newjansk. A combination of iridium and osmium has been found in Borneo, and also (G = 19·5) in South America.

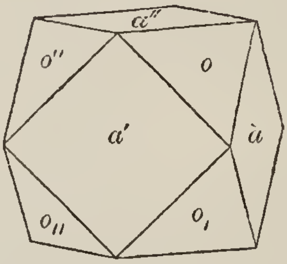
10. IRIDIUM.—Hexaedrisches Iridium; Mohs. Platiniridium; Hausmann. Iridium; Haidinger.

Cubic.

a 100, *o* 111.

aa′	90°	0′
oo′	70	32
oa	54	44

FIG. 99.



Combination. *ao.* Cleavage. *a*, difficult to obtain. Opaque. Lustre metallic. Silver-white, inclining to yellow exteriorly, and to grey in the interior. Slightly ductile. H = 6·0…7·0. G = 22·65…22·80.

Unchangeable before the blowpipe. Insoluble in acids.

Ir,Pt, iridium and platinum.

Analysis by Svanberg:

Iridium	76·85
Platinum	19·64
Palladium	0·89
Copper	1·78

Occurs in small isolated crystals and rounded grains, with osmiridium and platinum, at Nischne Tagilsk and Newjansk in the Ural, and Ava in the East Indies.

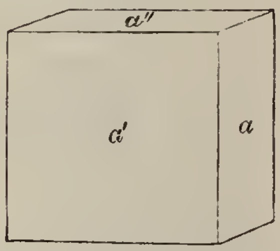
11. PLATINUM.—Native Platina; Phillips. Platine natif ferrifere; Hauy. Hexaedrisches Platin; Mohs. Polyxen; Hausmann. Platin; Haidinger.

Cubic.

a 100.

aa′ 90° 0′

FIG. 100.



No cleavage. Fracture hackly. Opaque. Lustre metallic. Steel-grey. Streak the same, bright. Ductile. H = 4·0…4·5. G = 18·947, from South America; 17·3…17·5, from Russia. Frequently magnetic.

Before the blowpipe, alone and with fluxes, infusible and unchangeable. Soluble only in nitromuriatic acid. The solution yields a lemon-yellow precipitate with sal-ammoniac.

Pt, platinum, with iron, iridium, osmium, rhodium, palladium, copper.

Analyses of platinum *a*, *b* from Nischne Tagilsk, *c* from Goroblagodat, *d* from Barbacoas, all by Berzelius, *e* from Choco, *f* from Pinto, both by Svanberg:—

	a	*b*	*c*	*d*	*e*	*f*
Platinum	78·94	73·58	86·50	84·30	86·16	84·34
Iridium	4·97	2·35	—	1·46	1·09	2·52
Rhodium	0·86	1·15	1·15	3·46	2·16	3·13
Palladium	0·28	0·30	1·10	1·06	0·35	1·66
Osmium	(not determined)			1·03	0·97	0·19
Iron	11·04	12·98	8·32	5·31	8·03	7·52
Copper	0·70	5·20	0·45	0·74	0·40	trace
Manganese	—	—	—	—	0·10	0·31
Osmium-iridium	1·96	2·30	1·40	—	1·91	1·56
Earthy substances	—	0·60	—	0·72	—	—

A silver-white variety from the Brazils (G = 16·94) in small round grains, according to Svanberg, consists of

Platinum	55·44
Iridium	27·79
Rhodium	6·86
Palladium	0·49
Osmium	a trace
Iron	4·14
Copper	3·03

Occurs very rarely in cubic crystals, usually in small plates or rounded grains having a smooth bright surface, less frequently in large grains and rounded lumps, of which the largest known weighs 8·33 kilogrammes.

Is found with gold, in veins of quartz and brown iron-ore, in syenite, near Santa Rosa de Osos, in the province of Antioquia; but much more abundantly, accompanied by gold, osmiridium, iridium, palladium, chromic iron-ore, magnetic iron-ore, zircon, corundum, and occasionally diamond, in the alluvial sand of almost all the valleys on the eastern slope of the Ural mountains; at Bogoslowsk, Kuschwinsk, Newjansk, Miask: also on the western slope at Nischne Tagilsk, where it appears to have been originally imbedded in serpentine with chromic iron-ore. It occurs under similar circumstances in South America, in the provinces of Choco and Barbacoas; in the province of Matto Grosso, in the Brazils; in the valley of Jaky in St. Domingo; in Borneo, where it appears to have been originally disseminated in serpentine; and in small quantity in the gold sand of the Rhine; with the gold of the country of Rutherford in North Carolina.

12. PALLADIUM.—Native palladium; Phillips, Hausmann, Haidinger. Oktaedrisches Palladium; Mohs.

Cubic.

o 111.

oo′ 70° 32′. (fig. 101.)

Fracture hackly. Opaque. Lustre metallic. Light steel-grey. Ductile. H = 4·5...5·0. G = 11·8...12·14.

When heated to a certain point, takes a blue colour, which disappears on ignition. Infusible before the blowpipe. Melts with sulphur. With nitric acid yields a red solution.

Pd, palladium, with a little platinum and iridium.

Occurs in very small octahedrons and grains, which are sometimes an aggregation of radiating fibres, with grains of platinum in auriferous sand, in the Brazils. Also with gold and clausthalite at Tilkerode in the Harz, in very small bright crystals, which appear to be regular six-sided prisms (fig. 91) perfectly cleavable parallel to *o*. Hence probably palladium is dimorphous.

13. GOLD.—Native gold; Phillips. Or natif; Hauy. Hexaedrisches Gold; Mohs. Gold; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *e* 210, *m* 311, *t* 421.

aa'	90° 0′		ee'	36° 52′		ta	29° 12′
oa	54 44		ee''	36 52		to	28 8
oo'	70 32		ma	25 14		tt'	17 45
da'	45 0		ma'	65 54		$tt_{,}$	25 12
dd'	60 0		mo	29 30			
ea'	26 34		mm'	50 29			

FIG. 101.

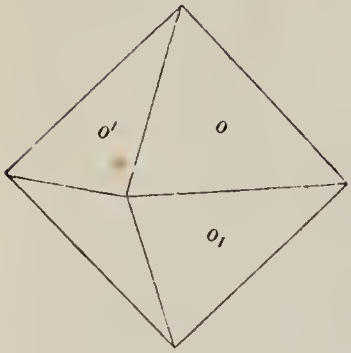


FIG. 102.

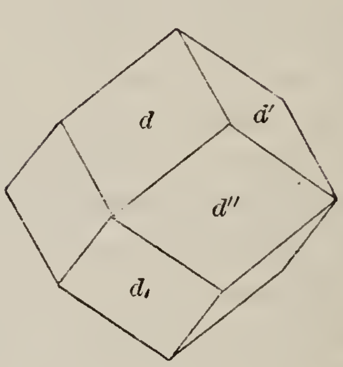


FIG. 103.

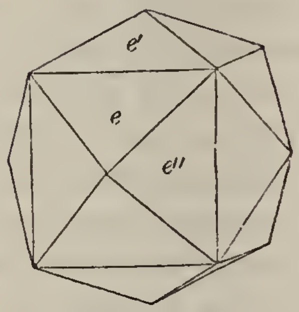


FIG. 104.

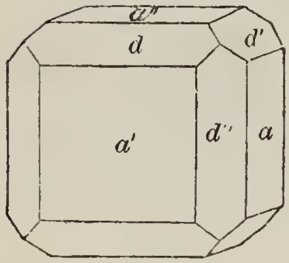


FIG. 105.

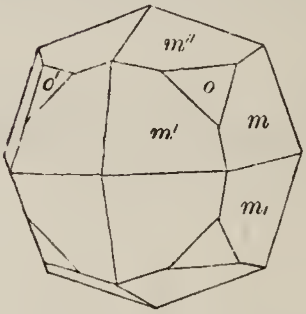
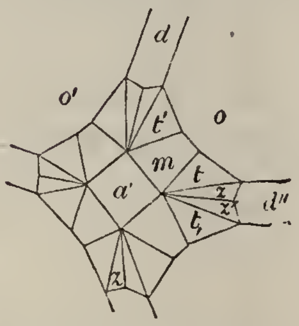


FIG. 106.



Forms and combinations. *a*, *o*, *d*, *e*, *m*, *ao*, *ad*, *od*, *am*, *om*, *aod*, *aodmtz*. Twins. Twin-face *o*. Cleavage, not observable. Fracture hackly. Opaque. Lustre metallic. Gold-yellow... brass-yellow. Streak bright. Extremely ductile and malleable. H = 2·5...3·0. G = 14·556...19·1.

Fusible before the blowpipe. In a bead of salt of phosphorus in the inner flame, pure gold remains unaltered, and the bead colourless and transparent; but an admixture of 0·3 per cent. of silver makes the bead opalescent when cold; a larger quantity of silver makes the bead yellow and opaque. Is decomposed by nitromuriatic acid when it does not contain more than 20 per cent. of silver, leaving a residue of chloride of silver.

Au, gold, with a variable quantity of silver, which in some cases amounts to 40 per cent., with traces of copper and iron.

Analyses of gold *a* from Schabrowskoi near Katharinenburg, *b* from Beresowsk, *c* from Perwo-Pawlowskoi near Beresowsk, *d* from Beresowsk, *e* from Newjansk, *f* from Goruschkoi near Nischne-Tagilsk, *g* from Füses in Transylvania, *h* from

Titiribi in Columbia, *i* from Syränowsk in the Altai, *k* from Vöröspatak in Transylvania, all by G. Rose: *l* tetrahedrons, *m* octahedrons, *n* dodecahedrons, *o* dodecahedron, *p* dodecahedrons, *q* dodecahedrons, all from Katharinenburg, by Awdejew; *r* from Eula in Bohemia, by Lampadius; *s* from California, by H. Henry:—

	a	*b*	*c*	*d*	*e*	*f*
Gold .	98·96	93·78	92·60	91·88	88·65	87·17
Silver .	0·16	5·94	7·08	8·03	10·64	12·41
Copper .	0·35	0·08	0·02	0·09	0·09	0·05
Iron .	0·05	0·04	0·06	trace	0·35	0·23

	g	*h*	*i*	*k*	*l*	*m*
Gold .	84·89	76·41	60·98	60·4	79·00	70·86
Silver .	14·68	23·12	38·38	38·74	20·34	28·30
Copper .	0·04	0·03	—	0·77	0·66	0·84
Iron .	0·13	trace	0·33			

	n	*o*	*p*	*q*	*r*	*s*
Gold .	95·3	95·83	92·71	91·21	96·9	86·57
Silver .	3·86	4·34	6·51	8·03	2·0	12·33
Copper .	0·84	0·33	0·78	0·76	—	0·29
Iron .					1·1	0·54

The colour approaches to brass-yellow, and the specific gravity diminishes as the quantity of silver increases. The first column of the following table exhibits the per centage of silver, the other three columns the specific gravity of the gold in its natural state, hammered and after fusion respectively.

0·16	19·10	—	19·10
3·86	18·77	18·89	—
4·34	—	—	18·79
5·23	18·44	18·66	—
8·35	17·96	18·02	17·97
9·02	17·59	17·75	—
10·65	17·48	—	17·73
12·07	17·40	—	17·54
16·15	17·06	17·06	—
20·34	—	16·03	—
28·30	—	—	15·63
38·38	—	—	14·56

Rhodium-gold, G = 15·5...16·8, contains from 34 to 43 per cent. of rhodium. Porpezite, from the Capitania Porpez in the Brazils, according to Berzelius, consists of gold 85·98, palladium 9·85, silver 4·17.

In attached crystals, capillary, ramose, in plates, disseminated, in grains and dust.

In felspathic and hornblende rocks, associated with pyrite, quartz, brown iron-ore. It exists in many ores and rocks in a state of such minute subdivision as to be invisible to the eye. It occurs frequently in conglomerates, containing oxide of iron, with magnetic and titanic iron-ores, platinum, zircon, &c., in alluvial deposits, and in the sands of rivers into which it has been washed after the disintegration of the rocks in which it was previously contained. Is found in veins of green-stone and syenitic porphyry of Hungary and Transylvania, at Kremnitz, Schemnitz, Nagyag, Salathna and Offenbanya; also at Antioquia and Choco in South America; in veins of quartz and oxide of iron, in green-stone, between the rivers Yadkin and Katawa in North Carolina, and in the island of Aruba near Curaçao; in veins in slate in New Spain, Mexico, Peru, and Beresowsk; in beds at Pösing and Magurka in Hungary; in the Banat of Temeswar; at Rauris and Schellegaden in Salzburg; disseminated in porphyry at Vöröspatak in Transylvania; in itacolumite and itabirite at Villa Ricca, Matto Grosso and Diamantina in the Brazils; in Bohemia at Eule, Neuknin, Bergreichenstein; in Norway at Kongsberg; at Schlangenberg in Siberia; at Tilkerode in the Harz in seleniuret of lead; at Schwarzgrund near Rudolstadt; the Hundsrück; Aedelfors in Sweden; La Gardette in France; in Spain. In alluvial soil in the Ural and Altai, especially between Newjansk and Nischne-Tagilsk; in North Carolina, Mexico, Peru, the Brazils, Chile, Aruba, St. Domingo, Bohemia, Ohlapian in Transylvania; in Africa, Thibet, China, Java, Borneo, Sumatra; at Crogan Kinshela in Wicklow; Glen Turret in Perthshire; in the stream-works of Cornwall; in the sands of the Danube, Rhine, Lech, Inn, Isar, Edder; in Upper California and New Mexico.

In the Turner Catalogue Mr. Levy has figured a crystal of gold, No. 5, which, for a reason he there assigns, the fear of damaging the specimen, he says he did not measure. Dufrénoy supposes the crystal to be a twin of the form *m*, in which several of the faces are wanting, like the crystal of silver from Kongsberg, described by G. Rose in Poggendorff's Annalen. B. 64. S. 533. This conjecture has been confirmed by the measurement of a crystal of gold of the same character, in Mr. Brooke's collection. The angles between the several faces *m* of one individual and the faces of the other symmetrically opposed to them, are 121° 0′, 62° 58′, 20° 3′ respectively.

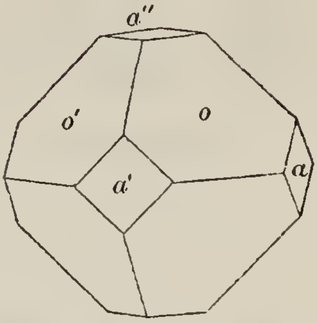
14. SILVER.—Native silver; Phillips. Argent natif; Hauy. Hexaedrisches Silber; Mohs. Silber; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *e* 210, *h* 410, *m* 311.

aa′	90°	0′	*ea*	26°	34′
oa	54	44	*ha*	14	2
da′	45	0	*ma*	25	14
do	35	16	*mo*	29	30

FIG. 107.



See also fig. 105.

Forms and combinations. *a*, *o*, *e*, *m*, *ao*, *om*, *ode*. Crystallizes from fusion in octahedrons. The faces *o* are striated parallel to their intersections with *a*: the other faces rough but even. Twins. Twin-face *o*. Cleavage not observable. Fracture hackly. Opaque. Lustre metallic. Silver-white. Liable to tarnish. Streak bright. Malleable. H = 2·5...3·0. G = 10·1 ...11·0.

Fusible before the blowpipe. Soluble in nitric acid. The addition of hydrochloric acid to the solution produces a copious white precipitate, which turns black on exposure to the light.

Ag, silver.

Some varieties contain very small quantities of copper, antimony, and arsenic; others contain gold, have a tinge of yellow, and a higher specific gravity. According to Fordyce, a variety from Kongsberg contained 28 per cent. of gold.

In crystals, in aggregations of minute octahedrons and cubes, producing dendritic and capillary forms, massive.

Occurs in veins, rarely in beds, in crystalline slate-rocks, gneiss, mica slate, hornblende slate, granite, syenite, porphyry, with arsenic and various ores of silver. Is found at Kongsberg in Norway; Sahla in Sweden; Freyberg, Johann-Georgenstadt, Schneeberg, Marienberg and Annaberg in Saxony; Joachimsthal, Przibram and Ratiborzitz in Bohemia; Schemnitz in Hungary; Felsöbanya and Kapnik in Transylvania; Schlangenberg in Siberia; Andreasberg in the Harz; Wittichen and Wolfach in Baden; Klausen in the Tyrol; Allemont and Markirchen in France; most abundant in Peru, Mexico, and Chile; in several places in Cornwall; at Alva in Scotland.

15. AMALGAM.—Native amalgam; Phillips. Mercure argental; Hauy. Dodekaedrisches Mercur; Mohs. Amalgam; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *f* 310, *n* 211, *p* 122, *s* 321.

aa′	90°	0′	*do*	35°	16′	*pa*	70°	32′
oo′	70	32	*na*	35	16	*po*	15	48
oa	54	44	*no*	19	28	*pd*	19	28
dd′	60	0	*dn′*	30	0	*fa′*	18	26
da′	45	0	*sd*	19	6			

FIG. 108.

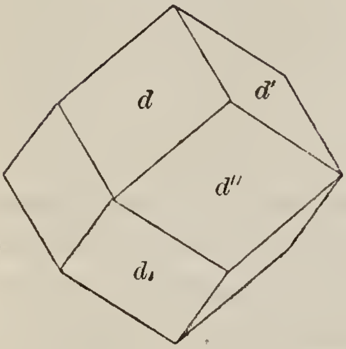


FIG. 109.

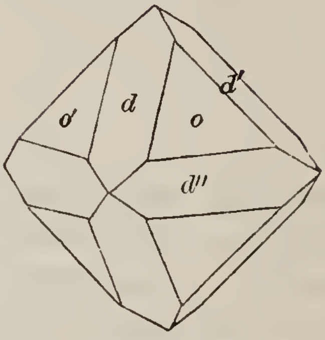
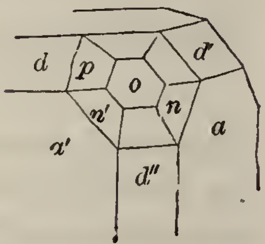


FIG. 110.



Form and combinations. *d*, *od*, *adn*, *dns*, *aodpn*, *aodfns*. Faces smooth and bright. Cleavage. *d*, traces. Fracture conchoidal...uneven. Opaque. Lustre metallic. Silver-white. Streak the same. Brittle. H = 3·0...3·5. G = 13·7...14·1:

In the matrass yields mercury, leaving a spongy mass of silver. Easily soluble in nitric acid.

Ag,Hg, silver and mercury in indefinite proportions.

Consists, according to the analyses of Heyer, Cordier, and Klaproth, of

Silver	25·00	27·50	36·00
Mercury	73·30	72·50	64·00

The first and second analyses correspond nearly to the formula $AgHg^3$, the third to $AgHg^2$.

In attached crystals and thin plates, investing other minerals, compact.

Occurs in beds containing mercury and cinnabar. Is found at Moschell-landsberg and some other places in the Palatinate; Szlana in Hungary; Almaden in Spain; and, it is said, at Allemont in France, and Sahla in Sweden.

16. ARQUERITE.—Arquerit; Haidinger.

Cubic.

o 111.

oo′ 70° 32′. (fig. 101.)

Opaque. Lustre metallic. Silver-white. Malleable and extensible. H = 2·0...2·5. G = 10·8.

Chemical characters the same as those of amalgam.

Ag^6Hg, silver 86·49, mercury 13·51. Domeyko.

Is found in the Arqueros mine in the province of Coquimbo in Chile.

17. MERCURY.—Native quicksilver; Phillips. Mercure natif; Hauy. Flüssiges Mercur; Mohs. Quecksilber; Hausmann. Merkur; Haidinger.

Cubic.

o 111.

oo′ 70° 32′. (fig. 101.)

At above —40° C liquid. Opaque. Lustre metallic. Tin-white. When solid, G = 14·4. Its specific gravity at 0° C. is 13·59593 times that of water at 4° C.

Boils at 360° C. Sublimes in the matrass. Is entirely volatilized before the blowpipe. Soluble in nitric acid.

Hg, mercury.

Occurs in drops in cinnabar; sometimes in crevices of the rocks containing cinnabar. Is found at Idria, in Carniola; Almaden and Almadenejos, in Spain; Horzowitz, in Bohemia; Wolfstein, Mörsfeld and Moschellandsberg in the Palatinate; Sterzing in the Tyrol; Delach in Carinthia; Huancavelica in Peru; China; Clausthal in the Harz; in tertiary formations near Lisbon and Montpellier.

18. LEAD.—Plomb natif volcanique; Hauy. Blei; Hausmann, Haidinger.

Cubic. *o* 111.

oo′ 70° 32′. (fig. 101.)

Crystallizes from fusion in the form *o*. Opaque. Lustre metallic. Lead-grey; acquires a blackish tarnish by exposure. Fracture hackly. Ductile and malleable. H = 1·5. G = 11·35.

Very fusible before the blowpipe. Volatilizes and deposits a sulphur-yellow sublimate on the charcoal. Soluble in nitric acid.

Pb, lead.

Capillary, dendritic, disseminated.

Is said to have been found in lava in the island of Madeira; in carboniferous limestone at Bristol; Kenmare in Ireland; containing silver in the auriferous sand of the Salzach.

19. TIN.—Native tin; Phillips. Zinn; Haidinger.

Pyramidal. 101,001 = 21° 5′·5.

a 100, *m* 110, *s* 101, *t* 301, *p* 111, *r* 331.

aa′	90°	0′	*pa*	70°	13′	*pm*	61°	24′
ma	45	0	*ra*	52	53	*rm*	31	26
pp″	57	13	*sm*	75	16	*pp′*	39	35
ss″	42	11	*tm*	57	39	*rr′*	74	13
tt″	98	20	*sa*	68	55	*ss′*	29	29
rr″	117	8	*ta*	40	50	*tt′*	64	41

FIG. 111.

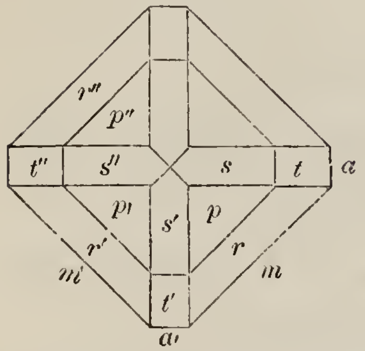


FIG. 112.

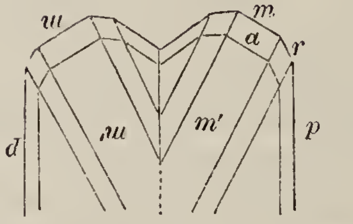
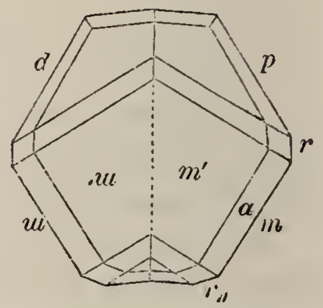


FIG. 113.



Twins. Twin-face *p* (fig. 112). *mu* = 57° 13′. Twin-face *r* (fig. 113). *pd* = 120° 5′, *mu* = 117° 8′. Lustre metallic. Tin-white. Ductile. Malleable. H = 2·0. G = 7·178. After fusion, G = 7·293.

Sn, tin.

The occurrence of native tin in Cornwall and other places is very problematical. The crystals above described were obtained by the reduction of the metal from a solution of its protochloride by a voltaic current. Tin, in combination with a small quantity of lead, is said to occur with osmiridium and other substances accompanying gold, in the stream-works in the neighbourhood of Miask in Siberia.

20. COPPER.—Native copper; Phillips. Cuivre natif; Hauy. Oktaedrisches Kupfer; Mohs. Kupfer; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *e* 021, *k* 052, *m* 311.

aa′	90°	0′	*dd′*	60°	0′	*ka′*	21°	48′
oo	70	32	*ea′*	26	34	*kd*	23	12
oa	54	44	*ed*	18	26	*mm′*	50	29
da′	45	0	*ee′*	36	52	*mm,*	35	6
do	35	16	*ee″*	36	52			

FIG. 114.

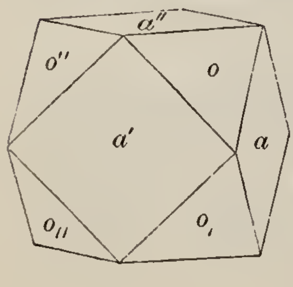


FIG. 115.

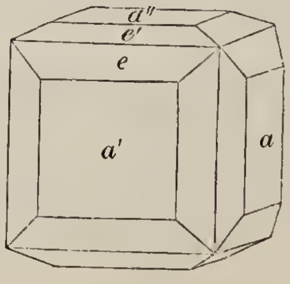


FIG. 116.

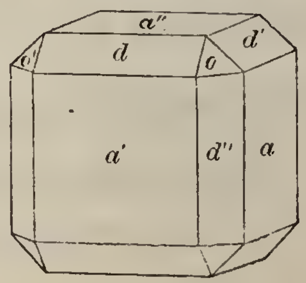


FIG. 117.

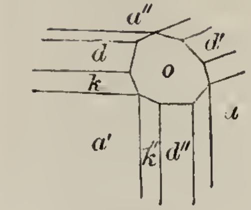


FIG. 118.

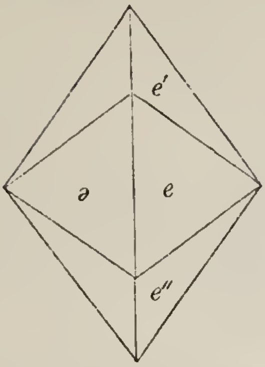
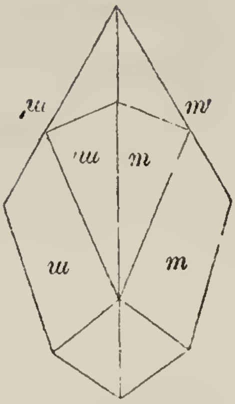


FIG. 119.



Forms and combinations. *a*, *o*, *d*, *e*, *ao*, *ad*, *ae*, *aod*, *aode*, *aodk*. Twins. Twin-face *o*. *eə* = 100° 32′ (fig. 118); *mu* = 121° 0′, *,um′* = 62° 58′ (fig. 119). No cleavage. Fracture hackly. Opaque. Lustre metallic. Copper-red. Streak the same, bright. In extremely thin films, green by transmitted light. Ductile. H = 2·5...3·0. G = 8·5...8·9.

Fusible before the blowpipe, colouring the flame green. Soluble in nitric acid; also in ammonia, with access of atmospheric air, yielding a blue solution.

Cu, copper, usually very nearly pure, sometimes with small quantities of iron and other metals.

Crystallized, frequently aggregated, so as to produce dendritic, capillary, laminar forms, and massive.

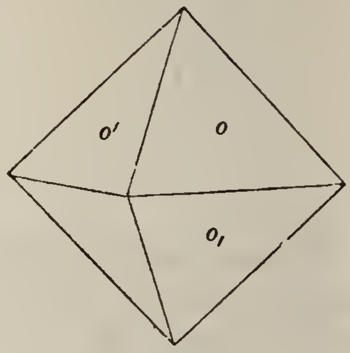
Occurs in veins and beds with cuprite, towanite, redruthite, carbonates of copper oxide. Also disseminated in rocks of all formations, rarely in amygdaloidal trap rocks, sometimes in isolated blocks. Is found in beds in porphyry at Moldawa, Saska and Orawitza in the Banat of Temeswar; at Herrngrund in the county of Sohler; at Schmölnitz and Gölnitz in the county of Gömör in Hungary; Nischne-Tagilsk, Bogoslowsk and Turginsk in Siberia, usually imbedded in granular limestone; in Cornwall in many of the mines near Redruth, the consolidated mines, Wheal Buller near the Lizard in serpentine; Mansfeld, Kamsdorf; Chessy near Lyons in France; Spain; Fahlun in Sweden; Röraas in Norway; Hudson's Bay; in large blocks to the south of Lake Superior; in Massachusetts, Connecticut, New Jersey; Cuba; in the Brazils and Chile, often in large masses; China, Japan; Rheinbreitbach near Neuwied; Nassau; the mining districts of Saxony; with prehnite in amygdaloidal rocks at Oberstein, beautifully crystallized; with chabasie in Naalsöe, Sandöe, in the Faröe Isles; in Zell, one of the Shetlands, in serpentine, and in Mainland in red sand-stone. Copper crystallizes from fusion in cubes and octahedrons; occurs in octahedral crystals in artificial avanturine; is deposited from sulphate of copper on iron and sometimes on wood.

21. IRON.—Native iron; Phillips. Fer natif; Hauy. Oktaedrisches Eisen; Mohs. Eisen; Hausmann, Haidinger.

Cubic.

a 100 cleavage, *o* 111.

FIG. 120.



aa′	90°	0′
oo′	70	32
oa	54	44

Cleavage *a*, seldom perceptible, and difficult to obtain. Fracture hackly. Surface rough. Opaque. Lustre metallic. Light steel-grey. Streak the same, bright. Highly magnetic. Ductile. H = 4·5. G = 7·0...7·8.

Fusible with great difficulty before the blowpipe. Soluble in hydrochloric acid.

Fe, iron.

Iron of terrestrial origin is almost quite pure, or contains a small admixture of other metals, but without nickel.

Metallic iron has been found in a vein at Oulle near Allemont in Dauphiné; in lava at Graveneire in Auvergne; in thin flexible leaves in the iron-stone conglomerate near Itabira do Matto Dentro in the Brazils. It is also said to have been found at Pen-Yan in Yates county in the United States. A mass, consisting of iron, 92·5, lead, 6·0, copper, 1·5, according to Klaproth, was found with magnetite at Gross Kamsdorf not far from Saalfeld in Thuringia.

Iron frequently crystallizes in octahedrons after fusion. After long-continued exposure to a high temperature, but lower than that at which iron fuses, it becomes cleavable in three directions, making right angles with each other.

Meteoric iron contains nickel, cobalt, and some other metals.

Analyses of meteoric iron *a*, *b* from Bohumilitz, *c* of the Pallas iron, *d* from Elbogen, all by Berzelius; *e*, *f* from Clairborne in Alabama, the former by Jackson, the latter by Hayes:—

	a	*b*	*c*	*d*	*e*	*f*
G . .	7·61 . . .	7·71	—	7·74	—	—
Iron . .	92·473	93·775	88·042	88·231	66·561	83·572
Nickel .	5·667	3·812	10·732	8·517	24·708	12·665
Cobalt .	0·235	0·213	0·455	0·762	—	—
Copper .	—	(and tin	0·66)	sulphur	4·000	—
Manganese	—	—	0·132	and chrome	3·240	— .

	a	*b*	*c*	*d*	*e*	*f*
Magnesium	—	—	0·050	0·279	—	—
Carbon .	—	—	0.043	(chlorine	1·480	0·907)
Insoluble .	1.625	2·200	0·480	2·211	FeS	2.395

Analyses of the residue in *b*, *c*, *d*, insoluble in nitric and hydrochloric acids, by Berzelius; *n* of the white, flexible, magnetic scales H = 6·5, G = 7·01...7·22, (schreibersite) found in the Arva meteoric iron, by A. Patera:—

	b	*c*	*d*	*n*
Iron . . .	65·987	48·67	68·11	87·20
Nickel . .	15·008	18·33	17·72	4·24
Magnesium .	—	9·66		—
Phosphorus .	14·023	18·47	14·17	7·26
Silicon . .	2·037	—	—	—
Carbon . .	1·422	—	—	traces

Analyses of iron *g* from Hraschina, *h* from the Cape, *i* from Lenarto, all by Wehrle; *k* of the magnetic particles disseminated through a meteoric stone which fell at Klein Wenden, near Nordhausen, on the 16th of September, 1843; *l* of the magnetic portions of a meteorite which fell at Nashville, in Tenessee, in May, 1827, both by Rammelsberg; *m* of the magnetic portions of a stone which fell near Utrecht on the 2nd of June, 1843, by Baumhauer:—

	g	*h*	*i*	*k*	*l*	*m*
G . .	7·78	7·66	7·79	7·513	—	—
Iron . .	89·784	85·608	90·883	88·980	85·00	86·64
Nickel .	8·886	12·275	8·450	10·351	13·01	13·04
Cobalt .	0·667	0·887	0·665	—	1·42	—
Copper .	—	—	0·002	0·213	0·57	0·27
Tin . .	—	—	—	0·349		—
Phosphorus .	—	—	—	0·107	—	0·05

The meteoric iron found at Seeläsgen, G = 7·7345, consists, according to the analysis by Rammelsberg, of—iron, with a small quantity of manganese, 92·327, nickel 6·228, cobalt 0·667, copper and tin 0·049, silica 0·026, carbon 0·520, remainder 0·183. It contains grains of a brownish-yellow substance, soluble in hydrochloric acid, G = 4·787, consisting of—sulphur 28·155, iron 65·816, nickel and cobalt 1·371, copper 0·566, oxide of chrome 1·858, protoxide of iron 0·874. The insoluble remainder is a mixture of silica, scales of graphite, and bright silver-white, very magnetic acicular crystals, which consist approximately of —sulphur 0·26, phosphorus 6·13, iron 59·23, nickel 26·78, copper 0·78, tin 0·20, with a mechanical mixture of carbon 6·62.

According to Rammelsberg, 100 parts of the Klein Wenden meteorite consisted of—alloy of iron and nickel 22·904, magnetic iron pyrites 5·615, chromite 1·040, olivine 38·014, labradorite 12·732, augite 19·704. The analysis *k* of the alloy of nickel and iron has already been given. The remaining simple minerals are composed as follows:—

Chromite.

Oxide of chrome	59·85
Protoxide of iron	27·93
Magnesia	12·22

Olivine.

Silica	39·60
Magnesia	47·37
Lime	2·12
Protoxide of iron	10·72
Protoxide of manganese	0·19

Labradorite.

Silica	16·28
Alumina	9·08
Lime	3·84
Potash	0·92
Soda	0·71

Augite.

Silica	54·64
Magnesia	23·69
Lime	2·01
Protoxide of iron	19·67

Of 100 parts of the Juvenas meteorite, 36·77 were capable of being decomposed by hydrochloric acid, and 63·23 were not capable of being decomposed by hydrochloric acid. The analyses of these two portions, by Rammelsberg, gave respectively:—

Silica	44·38
Alumina	33·73
Red oxide of iron	3·29
Lime	18·07
Magnesia	0·36
Soda	1·03
Potash	0·33
Phosphoric acid	0·54
Sulphide of iron	0·71

Silica	52·07
Alumina	0·24
Protoxide of iron	30·81
Lime	5·68
Magnesia	9·98
Soda	0·41
Chromite	2·13
Titanic acid	0·16

This meteorite may be regarded as consisting of:—

Christianite	36·75
Augite	60·00
Chromite	1·50
Sulphide of iron	0·25
Compounds containing phosphorus and titanium	1·50

When a polished surface of meteoric iron is immersed in nitric acid, different portions of the surface are unequally acted on by the acid, producing a series of deeply etched lines in three different directions, broad spaces less deeply etched than the lines, and narrow bands between the deep lines and broad shallow spaces, which appear to be very slightly, or not at all acted on by the acid, preserving their polish, and contain a larger proportion of nickel than the rest of the mass. A portion of the Pallas iron, after being acted upon by dilute acid, left a porous skeleton, consisting of—iron 57·18, nickel 34·00, magnesium 4·52, tin and copper 3·75, carbon 0·55. The parts of the surface on which the acid acts most, contain the smallest proportion of nickel.

Among the most remarkable masses of meteoric iron are—the Pallas iron, weighing originally 1600 ℔s, found in 1749, between Krasnojarsk and Abakansk in Siberia, in structure resembling a coarse sponge, the cavities of which are filled with olivine; a mass of 30,000 ℔s weight by estimation, found by Don Rubin de Celis, in 1783, in the province of Tucuman in South America; the 'verwünschte Burggraf,' of Elbogen in Bohemia, weighing 230 ℔s; a mass weighing 86 ℔s, which was seen to fall on the 26th of May, 1751, at Hraschina, near Agram in Croatia; a mass supposed to weigh 17,300 ℔s, discovered, in 1784, on the Riacho de Bemdegó in the Brazils; one of 300 ℔s weight, found, in 1793, between the great Fish river and Graf Reynet at the Cape of Good Hope; one of above 3000 ℔s, from the Red River in America, exhibiting octahedral crystals; another, or else part of the preceding, from the Red River, in which B. Silliman and Hunt found a small quantity of chlorine; a mass weighing 240 ℔s, found, in 1814, at Lenarto, in the county of Sáross in Hungary; one of 3300 ℔s, found, in 1805, at Bitburg in the district of Treves; one of 127 ℔s, found, in 1829, at Bohumilitz in Bohemia; iron containing cavities filled with olivine, found at Steinbach, between Eibenstock and Johanngeorgenstadt, in Saxony; 300 ℔s of iron, of sponge-like structure, containing olivine, found, in 1827, near the village of St. Pedro in Atacama in Peru; a mass of from 30,000 to 40,000 ℔s, found at Durango in Mexico; others, one of which weighed 18 ℔s, 32 feet beneath the surface in the gold stream-works of Petropawlowsk, 370 miles south-east of Kusnezk, and in small masses in considerable abundance in the Magura mountains near Szlanicz in Hungary; a piece of iron weighing 40 ℔s, found at Clairborne in Alabama, in which chlorine was first detected by Jackson; two masses, one 52 ℔s, the other 37 ℔s, which were seen to fall early in the morning of July 14th, 1847, at Braunau in Bohemia, consisting, according to the analysis by Fischer and Duflos, of—iron 91·882, nickel 5·517, cobalt 0·529, copper, manganese and arsenic 2·072, calcium, magnesium, silicon, carbon, chlorine, sulphur and chrome 2·072. A remainder, amounting to 1·3 per cent., insoluble in hydrochloric acid, composed of greyish-white, bright, magnetic plates, mingled with a black amorphous powder, consists of—iron 56·430, nickel 25·015, phosphorus 11·722, chrome 2·850, carbon 1·156, silica 0·985.

It occurs also, together with magnetic pyrites, disseminated in the greater number, though not in all, of the meteoric stones which have been preserved. These consist of various silicates, among which olivine, augite, amphibole, labrador, christianite, albite are found, and contain, in variable proportions, iron and nickel, with small quantities of carbon, sulphur, phosphorus, magnesium, cobalt, tin, copper, with phosphurets of iron, nickel, magnesium, magnetic pyrites, magnetite, chromite, &c. Iron has been found in those of which the times and places of fall are as follows:—

Ensisheim in Alsace, November 7th, 1492; Maurkirchen in the Circle of the Inn, November 20th, 1786; Eichstädt in Bavaria, February 19th, 1785; Barbotan in France, July 24th, 1790; Siena in Italy, June 16th, 1794; Wold Cottage in Yorkshire, December 13th, 1795; Krakhut near Benares, December 13th, 1798; l'Aigle in Normandy, April 26th, 1803; Timochin in Russia, March 13th, 1807; Erxleben in Prussian Saxony, April 5th, 1812; Chantonnay in La Vendée, August 5th, 1812; Brasky in the county of Limerick, September 10th, 1813; Lixna near Dünaburg in Russia, July 12th, 1820; Richmond, Chesterfield county in the state of Virginia, June 4th, 1828; Wessely in the circle of Hradish in Moravia, September 9th, 1831; Blansko in Moravia, November 25th, 1833; Macao near the mouth of the river Assu in the Brazils, December 11th, 1836; Gross-Divina near Budetin in the county of Trentschin in Hungary, July 24th, 1837; Grüneberg in Silesia, March 22nd, 1841; Chateau Reynard in France, June 12th, 1841; Milena in the county of Warasdin in Croatia, April 26th, 1842; Werchne Tschirskaja Stanitza on the Don, October 30th, 1843.

TELLURIDES.

22. SYLVANITE.—Graphic tellurium; Phillips. Tellur natif auro-argentifère; Hauy. Prismaticher Antimon-Glanz; Mohs. Schrift-tellur (in part); Hausmann. Sylvanit; Haidinger.

Prismatic. 011,010 = 48° 28′; 101,001 = 31° 26′; 110,100 = 55° 24′.

a 100, *b* 010, *c* 001, *d* 011, *x* 032, *e* 101, *f* 201, *g* 301, *h* 401, *m* 110, *n* 210, *v* 310, *r* 111, *s* 112, *t* 332, *o* 113, *q* 114, *l* 211, *u* 213, *w* 318, *p* 314, *i* 312, *y* 132.

bc	90°	0′
ca	90	0
ab	90	0
kb	66	7
kk′	47	46
db	48	28
dd′	83	4
xb	36	58
xx′	106	4
ea	58	34
ee′	62	52
fa	39	17
ff′	101	25
ga	28	37
gg′	122	46
ma	55	24
mm′	69	12
na	35	56
nn′	108	8
va	25	47
vv′	128	26
ra	65	25
rb	52	55
rc	47	6

sa	74°	24′
sb	67	3
sc	28	17
oa	78	57
ob	73	52
oc	19	44
qa	81	31
qb	77	39
qc	15	4
ta	61	8
tb	45	36
tc	58	13
ua	68	40
ub	74	43
uc	26	42

la	47°	33′
lb	60	43
lc	56	28
wa	77	10
wb	83	50
wc	14	17
pa	65	53
pb	78	37
pc	26	59
ia	50	2
ib	71	55
ic	45	31
ya	79	35
yb	38	12
yc	91	56

FIG. 121.

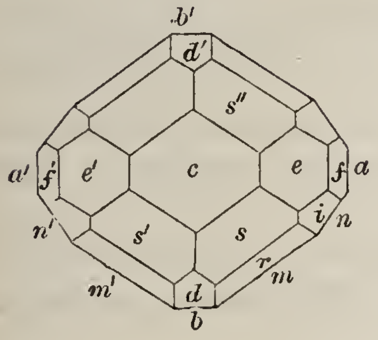
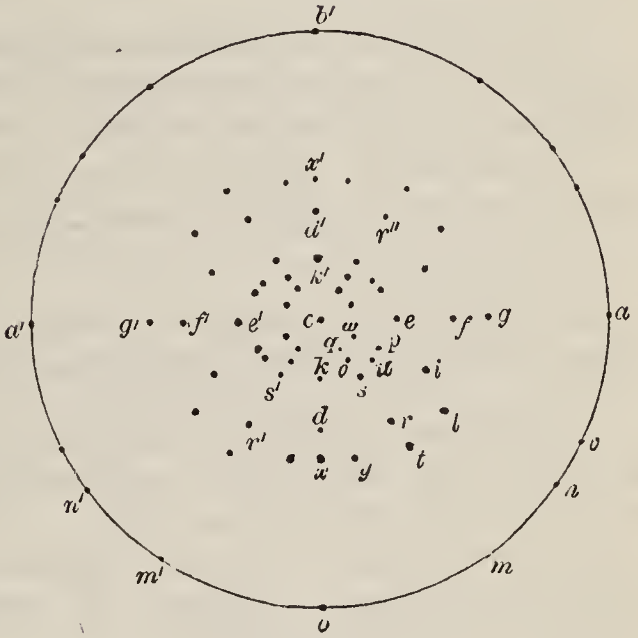


FIG. 122.



Cleavage. *c*. Fracture uneven. Opaque. Lustre metallic. Steel-grey...tin-white, silver-white, sometimes inclining to brass-yellow. Streak the same. Sectile. H = 1·5...2·0. G = 7·99 ...8·33.

In the open tube, yields a sublimate of tellurous acid, which, when heated, melts into clear drops. Before the blow-pipe on charcoal imparts a greenish-blue colour to the flame, deposits a white sublimate on the charcoal, and melts into a dark-grey bead, which, with soda, yields a globule of an alloy of gold and silver. Dissolves in nitric acid, with the exception of the gold. Is decomposed by nitro-muriatic acid, leaving chloride of silver.

Analyses *a* by Klaproth; *b*, *c* by Petz:—

	a	*b*	*c*
Gold	30·00	26·97	26·47
Silver	10·00	11·47	11·31
Lead	—	0·25	2·75
Copper	—	0·76	—
Tellurium	60·00	59·97	58·81
Antimony	—	0·58	0·66

Analyses of the variety called 'weisstellur,' *d* by Klaproth; *e*, *f*, *g* in crystals from Nagyag, *h*, *k* massive, all by Petz:—

	d	*e*	*f*	*g*	*h*	*k*
Gold	26·75	24·89	28·98	27·10	25·31	29·62
Silver	8·50	14·68	10·69	7·47	10·40	2·78
Lead	19·50	2·54	3·51	8·16	11·21	13·82
Tellurium	44·75	55·39	48·40	51·52	44·54	49·96
Antimony	—	2·50	8·42	5·75	8·54	3·82

In crystals and columnar and granular masses.

Is found in veins in porphyry, with gold and nagyagite, at Offenbanya and Nagyag in Transylvania.

The angles of sylvanite given above are deduced from the measurements of some crystals from Mr. Brooke's collection.

23. PETZITE.—Argent telluré; Dufrénoy. Untheilbares tellur; Mohs. Tellur silber; Hausmann. Petzit; Haidinger.

A specimen in Mr. Brooke's cabinet has some crystals upon it, which have three faces apparently at right angles to each other, possibly those of a cube.

Fracture even. Opaque. Lustre metallic. Between lead-grey and steel-grey. Streak the same. Malleable. H = 2·5 ... 3·0. G = 8·31...8·83.

In the open tube melts and yields a slight sublimate of tellurious acid. Before the blowpipe on charcoal, at a white heat, is volatilized, leaving a brittle globule of silver. In the matrass with soda and powdered charcoal, at a red heat, yields telluride of sodium, which with water forms a yellow solution. Soluble in hot nitric acid; after standing some time, the solution deposits crystals of telluriite of oxide of silver.

AgTe, silver, 62·77; tellurium, 37·23. A considerable portion of the silver is sometimes replaced by gold.

Analyses of petzite *a*, *b* from Siberia (G = 8·412...8·565), by G. Rose, *c* from Nagyag (G = 8·31...8·45), *d* from Nagyag (G = 8·72...8·83), both by Petz:—

	a	*b*	*c*	*d*
Silver	62·42	62·32	61·55	46·76
Gold	—	—	0·69	18·26
Tellurium	36·96	36·89	37·76	34·98
Iron	0·24	0·50	trace	trace
Lead, sulphur	—	—	trace	trace

Occurs in granular masses, with iron and copper pyrites, and blende in talk-slate, in the Sawodinski mine near Barnaul in Siberia; also at Nagyag in Transylvania.

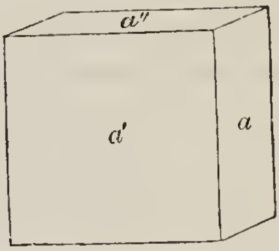
24. **ALTAITE.**—Plomb telluré; Dufrénoy. Hexaedrisches tellur; Mohs. Tellurblei; Hausmann. Altaite; Haidinger.

Cubic.

a 100 cleavage.

aa′ 90° 0′.

FIG. 123.



Cleavage *a* imperfect. Fracture uneven. Opaque. Lustre metallic. Tin-white, slightly inclining to yellow. Streak the same. Sectile. H = 3·0...3·5. G = 8·159.

Melts in the matrass, colouring the glass yellow where it touches it. Melts before the blowpipe in the inner flame into a globule which is volatilized, leaving a minute portion of silver. The globule is surrounded by a bright ring of telluride of lead, and, beyond the ring, by a brownish-yellow sublimate, which is dissipated by heat, and imparts a blue colour to the blowpipe flame. Soluble in nitric acid.

PbTe, lead, 61·9; tellurium, 38·1.

Analysis by G. Rose:—

Lead	60·35
Silver	1·28
Tellurium	38·37

Is found with petzite in the Sawodinski mine near Barnaul in the Altai.

25. **NAGYAGITE.**—Black tellurium; Phillips. Tellure natif auro-plombifere; Hauy. Pyramidaler Eutom-Glanz; Mohs. Blättertellur; Hausmann. Nagyagit; Haidinger.

Pyramidal. 101,001 = 61° 23′.

a 100, *c* 001, *m* 110, *e* 101, *r* 111.

ac	90°	0′
aa′	90	0
ma	45	0
ec	61	23
rc	68	56
re′	41	17
ee′	76	46
rr′	82	34

FIG. 124.

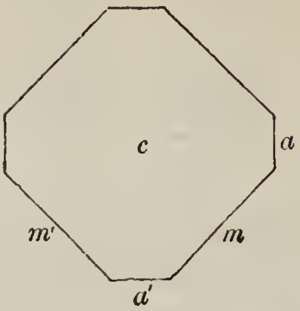
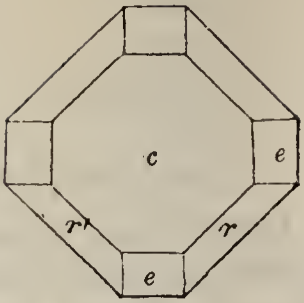


FIG. 125.



Combinations. *cma*, *crs*.

Cleavage. *c*, very perfect. Opaque. Lustre metallic. Blackish lead-grey. Streak the same. In thin leaves very flexible. Very sectile. H = 1·0 ... 1·8. G = 7·0 ... 7·2.

In the open tube emits a dense vapour and sulphurous acid, deposits a grey fusible sublimate of tellurate of oxide of lead close to the assay, and a white sublimate of tellurous acid at a greater distance. Before the blowpipe on charcoal melts easily, emits fumes, and deposits upon the charcoal a yellow sublimate, which disappears in the inner flame, imparting to it a blue colour. After long exposure to the flame, a malleable globule of gold is left. Soluble in nitric acid, with the exception of the gold.

Analyses of nagyagite from Nagyag *a* by Klaproth, *b* by Brandes, *c* by Berthier:—

	a	*b*	*c*
Lead . .	54·0	55·49	63·1
Gold . .	9·0	8·44	6·7
Silver . .	0·5	trace	—
Copper . .	1·3	1·14	1·0
Tellurium .	32·2	31·96	13·0
Antimony .	—	—	4·5
Sulphur . .	3·0	3·07	11·7

Petz found in three varieties 8·54, 7·81, 6·48 per cent. of gold, and only slight traces of silver.

In attached crystals, seldom; usually in lamellar masses, and disseminated.

Is found in veins with sylvanite, gold, pyrite, blende, antimonite, quartz, brown spar, at Nagyag and Offenbanya in Transylvania.

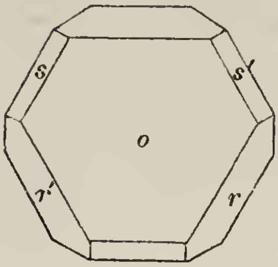
26. TETRADYMITE.—Bornine; Beudant. Rhomboedrischer Eutom-Glanz; Mohs. Tetradymit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 74° 44′.

o 111, *r* 100, *s* $\bar{1}11$, *z* 211 twin-face.

zo	42°	30′
ro	74	44
so	82	14
rr′	113	20
ss′	118	12
sr	59	6

FIG. 126.



Combinations. *or*, *ors*. Twins. Twin-face *z*. Usually one individual is united to each of three others according to this law. The faces *r*, *s* striated parallel to their intersections with *o*. Cleavage. *o*, very perfect. Opaque. Lustre metallic. Lead-grey inclining to tin-white, steel-grey inclining to red. Streak the same. Rather sectile. In thin leaves, flexible or elastic. H = 1·0...1·5. G = 7·4...7·5.

In the open tube melts, emits white fumes, and deposits a fusible sublimate of tellurous acid, and close to the assay a red sublimate of selenium, which may also be recognised by the smell. Before the blowpipe on charcoal melts easily into a bright metallic globule, emitting a smell of sulphur and selenium, and imparting a blue colour to the flame. A yellow sublimate is deposited near the assay surrounded by a blue sublimate. Soluble in nitric acid, with the exception of the sulphur.

Analyses of tetradymite from Schubkau, *a* by Wehrle, *b* by Berzelius, *c* by Hruschauer:—

	a	*b*	*c*
Bismuth . . .	59·84	58·74	59·2
Tellurium . . .	35·24	36·32	35·8
Sulphur . . .	4·92	4·35	4·6
Selenium . . .	trace	—	—

Is found in crystals and granular masses in a cleft in a trachytic conglomerate, at Schubkau, near Czernowitz, not far from Schemnitz, in Hungary.

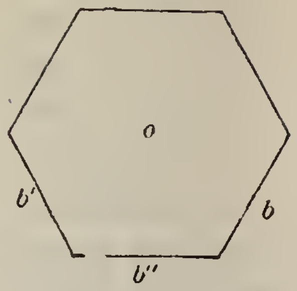
The value of *ro* in tetradymite is rather uncertain, being deduced from the angle between the faces *o* of two individuals of a presumed twin crystal, which Haidinger found = 85° nearly. The isomorphism of bismuth and tellurium renders it probable that they are capable of crystallizing together in all proportions, and that the sulphur, selenium, and silver are accidental in this and the following species, which, in that case, should be united.

27. TELLURWISMUTH. — Elastischer Eutom-Glanz; Mohs, Molybdänsilber, Haidinger.

Rhombohedral.

o 111, *b* $2\bar{1}\bar{1}$.

FIG. 127.



bo	90°	0′
bb″	60	0

Cleavage. *o*, very perfect. Opaque. Lustre metallic. Light steel-grey. Streak the same. In thin leaves, elastic. H = 2·5. G = 8·44.

Analysis by Wehrle:—

Bismuth	61·15
Tellurium . . .	29·74
Sulphur	2·33
Selenium	trace
Silver	2·07

Is found in cleavable masses at Deutsch-Pilsen near Gran in Hungary.

Minerals allied probably either to tetradymite or tellurwismuth (if they are distinct species) are found in the Gregory Nazianzen mine, in the Feritsel mountains, not far from Pojana in Transylvania, in chlorite state at Kakova near Rimaszombath in the county of Gömör in Hungary, Tellemarken in Norway? the Bastnäs mine at Riddahrhytta in Sweden? and in Cumberland. A mineral from S. José in the Brazils was found by Damour to consist of bismuth 79·15, tellurium 15·93, sulphur 3·15, selenium. A mineral from Whitehall mine in Virginia, analyzed by C. Fisher, contained—bismuth 51·65, tellurium 35·77, selenium 6·81, iron 1·25, silica 3·86. According to C. T. Jackson it consists of tellurium 35·05, bismuth 58·80, sulphur 3·65, gold, oxide of iron, silica 2·70.

ANTIMONIDES.

28. ANTIMONSILBER. — Antimonial silver; Phillips. Argent antimonial; Hauy. Prismatisches antimon; Mohs. Antimonsilber; Hausmann, Haidinger.

Prismatic. 011,010 = 40° 41′; 101,001 = 33° 53′; 110,100 = 60° 0′.

a 100, *b* 010, *c* 001, *d* 011, *e* 101, *p* 201, *m* 110, *n* 210, *q* 310, *r* 510, *y* 111, *z* 112, *s* 313.

dc	49°	19′
bc	90	0
ec	33	53
pc	53	20
ac	90	0
mb	30	0
nb	49	6
qb	60	0
rb	70	54
mm′	60	0
ya	66	21
yb	46	0
sb	72	9

eb	90°	0′
zc	33	53
yc	53	20
mc	90	0
za	73	49

zb	61°	8′
sa	57	57
sc	37	47
yy′	47	38
yy″	88	0

FIG. 128.

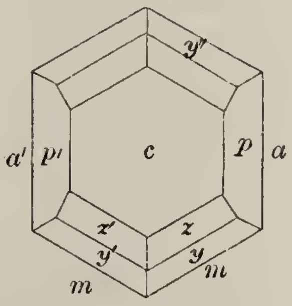
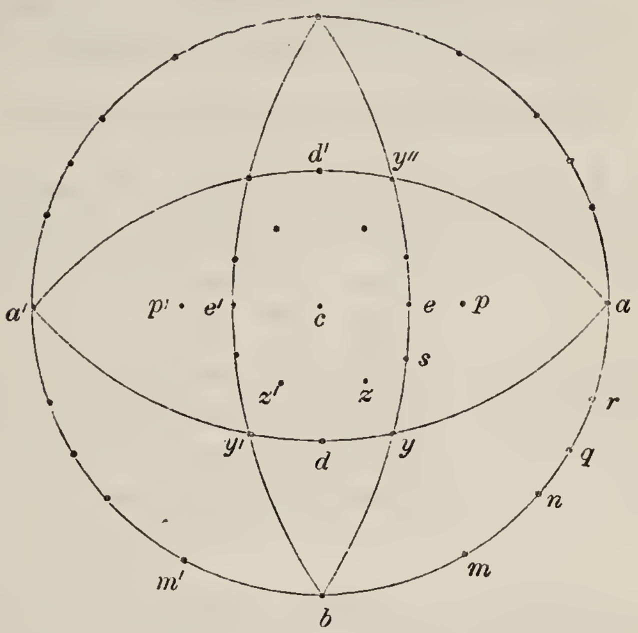


FIG. 129.



Combinations. *yc*, *em*, *ycp*, *cma*, *ybq*, *amez*, *czypma*. The faces *c* are striated parallel to their intersections with *a*. Twins. Twin-face *m*. Cleavage. *c*, *e*, distinct; *m*, imperfect. Fracture uneven. Opaque. Lustre metallic. Silver-white, inclining to tin-white. Streak the same. Sectile. H = 3·5. G = 9·4...9·8.

In the open tube yields oxide of antimony; the residuum is surrounded by a dark yellow glass. Melts easily before the blowpipe, emits fumes, and deposits a sublimate of oxide of antimony on the charcoal, leaving a malleable globule of silver. Partially soluble in nitric acid, leaving a residue of oxide of antimony undissolved.

Ag^4Sb, silver 76·99, antimony 23·01.

Analyses of antimonial silver from Andreasberg *a* by Abich, *b* by Vauquelin, *c* from Andreasberg, *d* from Wolfach, both by Klaproth:—

	a	*b*	*c*	*d*
Silver . .	75·25	78·00	77·00	76·00
Antimony .	24·25	22·00	23·00	24·00

In crystals, massive and disseminated.

Occurs in veins in granite, porphyry, and crystalline slate rocks, accompanied by silver, ruby-silver, arsenic, arsenical pyrites, galena, calcite. Is found at Andreasberg in the Hartz, Guadalcanal in Spain, Allemont in France, Mexico, and formerly at Altwolfach in Baden.

The arsenical silver of Andreasberg and Guadalcanal is supposed to be a mechanical mixture of antimonsilber with arsenic or arsenical pyrites.

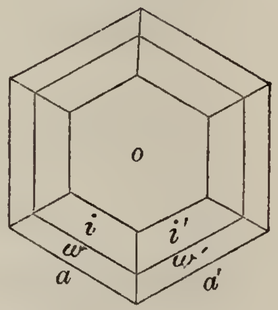
29. BREITHAUPTITE.—Nickel antimonial; Dufrénoy. Antimon nickel; Mohs, Hausmann. Breithauptit; Haidinger.

Rhombohedral. 100,111 = 59° 47′.

o 111, *a* $01\bar{1}$, *i* 231, *w* $25\bar{1}$.

ao	90°	0′
aa′	60	0
io	26	22
ii′	25	40
wo	56	5
ww′	49	2

FIG. 130.



Fracture uneven...conchoidal. Opaque. Lustre metallic. Light copper-red. Acquires a violet tarnish. Streak reddish-brown. Brittle. H = 5·0. G = 7·541.

When heated in the open tube, a little antimony sublimes. Before the blowpipe on charcoal deposits a copious sublimate of oxide of antimony, leaving a residue of nickel fusible with great difficulty. Easily and completely soluble in nitromuriatic acid.

Ni^2Sb, nickel 31·43, antimony 68·57.

Analyses by Stromeyer:—

Nickel . . .	28·95	27·05
Iron	0·87	0·84
Antimony . . .	63·73	59·71
Sulphuret of lead .	6·44	12·36

The sulphuret of lead is supposed to be derived from a mechanical admixture of galena.

Is found in thin tabular crystals, dendritic and disseminated, at Andreasberg, with smaltine, galena, blende, pyrargyrite, and arsenic.

ARSENIDES.

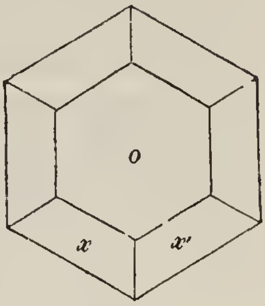
30. KUPFERNICKEL.—Copper nickel; Phillips. Nickel arsenical; Hauy. Prismatischer Nickel-Kies; Mohs. Kupfernickel; Hausmann. Nickelin; Haidinger.

Rhombohedral. 100,111 = 58° 36′·5.

o 111, *a* $01\bar{1}$, *x* 120. The face *x* truncates the edge *oa*.

ao	90°	0′
aa′	60	0
xo	43	25
xa	46	35
xx′	41	12
xx″	73	0

FIG. 131.



Combination. *ox*. Fracture conchoidal...uneven. Opaque. Lustre metallic. Copper-red; acquires a grey or blackish tarnish by exposure. Streak brownish-black. Brittle. H = 5·5. G = 7·2...7·8.

In the matrass yields no sublimate. Before the blowpipe on charcoal melts, with evolution of arsenical vapour, into a brittle white metallic globule. Roasted in an open tube, yields a sublimate of arsenious acid, and changes gradually into a green earthy mass, which fuses with soda and a little borax into a white, magnetic, metallic globule.

In powder, soluble in concentrated nitric acid, depositing arsenious acid, more readily soluble in a mixture of nitric and hydrochloric acids. The solution is green.

Ni^2As, nickel 44·02, arsenic 55·98.

Analyses of kupfernickel *a* from Riechelsdorf, by Stromeyer; *b* from Östre Langöe near Krageröe (G = 7·663) by Scheerer; *c* from Riechelsdorf, by Suckow; *d* from Oyer in the valley of Annivier in Wallis, massive (G = 7·39) by Ebelmen; *e* from the Rohnard mine near Olpe in Westphalia, by Schnabel:—

	a	*b*	*c*	*d*	*e*
Nickel . .	44·21	44·98	45·76	43·50	45·37
Iron . .	0·34	0·21	2·70	0·45	—
Copper . .	—	0·11	(cobalt	0·32)	1·44
Lead . .	0·32	—	antimony	0·05	—
Arsenic . .	54·73	54·35	53·69	54·05	52·71
Sulphur .	0·40	0·14	0·15	2·18	0·48

Occurs in veins, seldom in beds, in granite, clay slate, and transition rocks; in copper-slate, associated with smaltine with which it is frequently intermixed; sometimes with rammelsbergite bismuth, silver, arsenic, ruby-silver, galena, with baryte, calcite, siderite, quartz.

Is found at Schneeberg, Annaberg, Marienberg, Freiberg, Gersdorf in Saxony; Joachimsthal and Michelsberg in Bohemia; Saalfeld in Thuringia; Riechelsdorf and Bieber in Hessia; Andreasberg in the Harz; Wittichen and Wolfach in Baden; Allemont in Dauphiné; Schladming in Stiria; Orawitza in the Banat; in Spain; in the copper mines of Frederick county and at Chatham in Connecticut; Pengelly and Huelchance mines, Cornwall; Leadhills and Wanlock head, and in the carboniferous limestone of Linlithgowshire.

In the preparation of cobalt, an arsenide of nickel is formed, the crystals of which belong to the pyramidal system. *c* 001, *e* 101, *r* 111. (fig. 125.) $ec = 57° 49'·5$, $ee' = 73° 32'$, $re = 40° 15'$, $rc = 66° 1'$. Ni^3As. According to the analysis by Wöhler, consists of nickel 54·13, arsenic 45·87.

31. **RAMMELSBERGITE.**—Nickel arsenical blanc; Dufrénoy. Weissnickelerz; Hausmann, Rammelsbergit, Haidinger.

Cubic.

a 100, *o* 111, *d* 011.

aa′	90°	0′	*dd′*	60°	0′	
oo′	70	32	*da*	45	0	(figs. 114. 104.)
oa	54	44				

Traces of cleavage. Fracture uneven. Opaque. Lustre metallic. Tin-white. Acquires first a greyish and afterwards blackish tarnish by exposure to the atmosphere. Emits a smell of arsenic when broken. Brittle. H = 5·5. G = 6·432...6·735.

In the matrass yields a sublimate of metallic arsenic, leaving a copper-red residuum. In the open tube yields arsenic and arsenious acid. Melts readily before the blowpipe, emits fumes, continues to glow after removal from the flame, depositing crystals of arsenious acid, and at last leaves a brittle metallic globule. Soluble in nitric and in nitromuriatic acid, forming a green solution, which, on cooling, deposits crystals of arsenious acid.

$NiAs$, nickel 28·27, arsenic 71·73.

Analyses of Rammelsbergite *a* from Riechelsdorf, by Booth; *b*, *c* from Kamsdorf (G = 6·735), *d* from Allemont (G = 6·411), all by Rammelsberg:—

	a	*b*	*c*	*d*
Nickel . .	20·74	28·40	29·50	18·71
Iron . .	3·25	traces	traces	6·82
Cobalt . .	3·37	—	sulphur	2·29
Arsenic . .	72·64	70·34	70·93	71·11

In crystals and in granular or columnar masses.

Is found at Schneeberg in Saxony, with baryte at Riechelsdorf in Hessia, Kamsdorf near Saalfeld.

This mineral was called chloanthite by Breithaupt. This name, at the suggestion of Haidinger, has been transferred to the following species :—

32. CHLOANTHITE. — Weissnickelkies ; Breithaupt. Weissnickelerz (in part) ; Hausmann. Chloanthit ; Haidinger.

Prismatic.

m 110.

mm' 56°...57°.

Opaque. Lustre metallic. Tin-white, inclining to red on surfaces of recent fracture. H = 5·5. G = 7·099...7·188.

NiAs, nickel 28·27, arsenic 71·73.

Analysis of chloanthite from Schneeberg, by Hoffmann :—

Nickel	28·14
Bismuth	2·19
Copper	0·50
Arsenic	71·30
Sulphur	0·14

A mineral presenting these characters is found at Riechelsdorf and Schneeberg. Among the specimens we have examined from Schneeberg, we have found one of twin-crystals, somewhat analogous to those of harmotome, imbedded singly in the matrix, which give an angle of 57° 30′ between two faces, possibly the same as those measured by Breithaupt. We mention this fact merely on account of the remarkable character of the twin-crystals.

33. SMALTINE.—Tin-white cobalt ; Phillips. Cobalt arsenical ; Hauy. Oktaedrischer Kobaltkies ; Mohs. Speiskobalt ; Hausmann. Smaltin ; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *n* 211.

aa'	90°	0′
oo'	70	32
dd'	20	0
oa	54	44
da	45	0
do	35	16
na	35	16
no	19	28

FIG. 132.

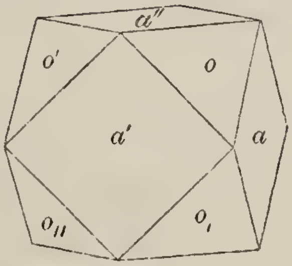
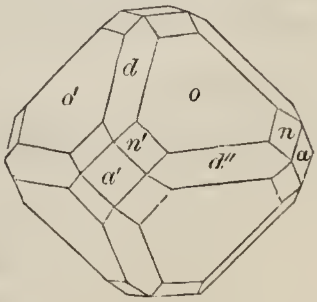


FIG. 133.



Forms and combinations. *a*, *o*, *ao*, *ad*, *aod*, *aodn*. Cleavage. *a*, *o*, *d* traces. Fracture uneven. *a*, *o* frequently curved. Opaque. Lustre metallic. Tin-white, inclining sometimes to steel-grey, sometimes to silver-white. Acquires a tarnish by exposure. Streak greyish-black. Brittle. Emits a smell of arsenic when broken. H = 5·5. G = 6·3...6·6.

In the matrass yields no sublimate. In the open tube yields a crystalline sublimate of arsenious acid. Before the blowpipe, on charcoal, emits arsenical fumes, and melts easily into a grey, magnetic, metallic globule, which is not malleable, and fuses with borax and salt of phosphorus into a blue glass. Soluble in nitric acid, leaving a residue of arsenious acid.

CoAs, cobalt 28·23, arsenic 71·77. The variety from Riechelsdorf, analyzed by Sartorius, consists principally of NiAs.

Analyses of smaltine *a* from Riechelsdorf, by Stromeyer; *b* from Tunaberg, by Varrentrapp; *c* from Riechelsdorf, by Sartorius:—

	a	*b*	*c*
Cobalt . .	20·31	23·44	9·17
Iron . .	3·43	4·95	2·24
Nickel . .	—	—	14·06
Copper . .	0·16	—	—
Arsenic . .	74·22	69·46	73·53
Sulphur . .	0·89	0·90	0·94

In crystals which are frequently cracked or rent in various directions, arborescent, reticulated, botryoidal, stalactitic, and amorphous masses.

Is found in veins in slate rocks at Schneeberg, Annaberg, Freiberg and Marienberg in Saxony, Joachimsthal in Bohemia, Riechelsdorf in Hessia, Schladming in Stiria, Dobschau in Hungary, Wittichen in Baden, Siegen, Sayn, Saalfeld, Mansfeld, France, Piedmont; Dolcoath, Herland and Huel Sparnon, in Cornwall.

34. SAFFLORITE.—Cobalt arsenical. Var. gris-noirâtre; Hauy. Eisenkobaltkies; v. Kobell. Eisenkobalterz; Hausmann. Safflorite; Haidinger.

Cubic.

a 100, *o* 111.

aa'	90°	0'	
oo'	70	32	(fig. 132.)
oa	54	44	

Fracture uneven, flat conchoidal. Light steel-grey, inclining to tin-white, and sometimes to lead-grey. Sometimes acquires a dark grey, or iridescent tarnish. H = 5·5. G = 6·92...7·3.

Chemical characters the same as those of smaltine, except that the solution in nitric acid yields a copious precipitate of oxide of iron on the addition of carbonate of lime.

RAs, where R is Co and Fe.

Analyses of safflorite *a* from Schneeberg, by E. Hoffmann; *b* by v. Kobell :—

	a	*b*
Cobalt . . .	13·95	9·44
Iron	11·71	18·48
Nickel . . .	1·79	—
Copper . . .	1·39	trace
Bismuth . . .	0·01	1·00
Arsenic . . .	70·37	71·08
Sulphur . . .	0·66	trace

Is found in very small crystals, reniform and botryoidal masses having a columnar structure, compact and disseminated.

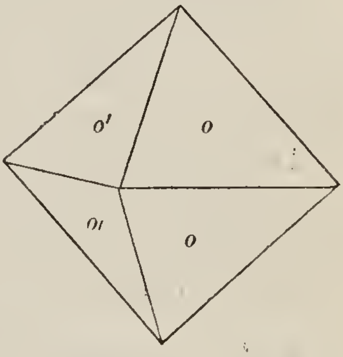
35. SKUTTERUDITE. — Hartkobalterz ; Hausmann. Skutterudit ; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *p* 122

aa′	90°	0′
oo′	70	32
oa′	54	16
dd′	60	0
da′	45	0
pa	70	32
pa′	48	11

FIG. 134.



Cleavage. *a*, distinct; *d*, traces. Fracture flat conchoidal. Opaque. Lustre metallic. Tin-white, inclining to lead-grey ; sometimes with a tarnish like blued steel. H = 6·0. G = 6·74... 6·84.

In the matrass yields a sublimate of metallic arsenic. In the open tube yields a copious sublimate of arsenious acid, leaving a rose-red powder. The reactions before the blowpipe are the same as those of smaltine.

Co^2As^3, cobalt 20·77, arsenic 79·24.

Analyses *a* by Scheerer, *b*, *c* by Wöhler:—

	a	*b*	*c*
Cobalt	20·01	18·5	19·5
Iron	1·51	1·3	1·4
Arsenic	77·84	79·2	79·0
Sulphur	0·69	—	—

Is found in crystals and granular masses, sometimes attached to crystals of cobaltine, in a bed of ore in mica slate, at Skutterud, in the parish of Modum, in Norway.

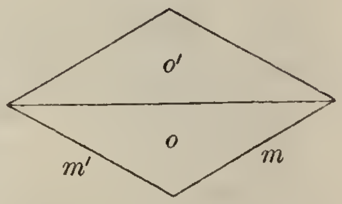
36. LÖLINGITE.—Arsenical Pyrites; Phillips. Fer arsenical axotome; Dufrénoy. Axotomer Arsenik-Kies; Mohs. Arsenikalkies; Hausmann. Lölingit; Haidinger.

Prismatic. 011,010=25° 40′; 101,001=41° 10′·5; 110,100=61° 13′.

c 011 cleavage, *o* 011, *e* 101 cleavage, *m* 110. *c* truncates the edge *oo′*; the edge *ee′* is perpendicular to the edges *oo′*, *mm′*.

mc	90°	0′
mm′	57	34
oo′	128	40
oc	64	20
ec	48	50

FIG. 135.



Cleavage. *c*, perfect; *e*, less perfect; *m*, traces. Fracture uneven. Opaque. Lustre metallic. Silver-white...steel-grey; acquires a dark tarnish by exposure. Streak greyish-black. Brittle. H = 5·5. G = 7·0...7·3.

In the matrass yields a sublimate of metallic arsenic. Before the blowpipe on charcoal, in the inner flame, emits arsenical fumes and melts into a black magnetic globule. Partially soluble in nitric acid, leaving a residue of arsenious acid.

R^4As^3. Fe^4As^3 gives iron 33·26, arsenic 66·74.

Analyses of lölingite from Reichenstein *a* by Karsten, *b* by E. Hoffmann, *c* by Meyer, *d* from Schladming by Scheerer:—

	a	*b*	*c*	*d*
Iron	32·35	28·70	31·36	13·49
Nickel	—	—	—	13·37
Cobalt	—	—	—	5·10
Arsenic	65·88	67·49	65·51	60·14
Sulphur	1·77	1·98	1·69	5·20

The sulphur is probably derived from a mixture of pyrrhotine and mispickel.

In crystals, more frequently in granular and columnar masses, and disseminated.

Is found in veins in clay-slate, with arsenic, pyrargyrite, antimonsilber, at Andreasberg, in beds of chalybite, at Löling near Hüttenberg in Carinthia, and Schladming in Stiria, and in Serpentine at Reichenstein in Silesia.

An arsenical iron from Sätersberg near Fossum in the parish of Modum in Norway, not crystallized, G = 7·09, appears to be represented by the formula FeAs. Two analyses by Scheerer gave:—

Iron . . .	27·39	28·14
Arsenic . . .	70·09	70·22
Sulphur . .	1·28	1·28

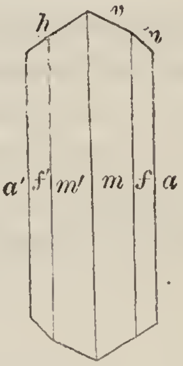
37. PLACODINE. — Placodine; Dufrénoy. Plakodin; Hausmann, Haidinger.

Oblique. 101,100 = 64° 56′; 111,010 = 53° 5′; 101,001 = 28° 16′.

a 100, *n* 201, *v* 101, *h* 1̄01, *m* 110, *f* 320.

na	45°	15′
va	64	56
ha	120	5
fa	46	32
ma	57	44
ff′	86	56
mm′	64	32

FIG. 136.



Combinations. *amhv*, *amfhvn*. Cleavage. *m*, *a*, *v*, traces. Opaque. Lustre metallic. Between bronze-yellow and copper-red. Streak black. Brittle. H = 5·0...5.5. G = 7·99...8·062.

In the open tube yields a sublimate of arsenious acid, and some sulphurous acid. Readily fusible before the blowpipe. In the inner flame, imparts a blue colour to glass of borax; in the outer flame, the reddish-brown colour of oxide of nickel. Soluble in nitric acid.

Ni^4As, nickel 61·19, arsenic 38·81.

Analysis of placodine by Plattner :—

Nickel	57·04
Cobalt	0·91
Copper	0·86
Iron	trace
Arsenic	39·71
Sulphur	0·62

Is found in attached tabular crystals at Müsen in Siegen, with chalybite and gersdoffite.

38. **DOMEYKITE.** — Arseniure de Cuivre ; Domeyko. Weisskupfer ; Hausmann. Domeykit ; Haidinger.

Fracture uneven…conchoidal. Opaque. Lustre metallic. Tin-white ; acquires a yellowish or variegated tarnish. H = 3·5.

Melts easily before the blowpipe, emitting a strong arsenical smell. After the arsenic is driven off, yields a bead of copper.

Cu^6As, copper 71·72, arsenic 28·27.

Analyses of domeykite *a* from Calabazo, *b* of a variety mingled with towanite from the San Antonio mine :—

	a	*b*
Copper . . .	71·65	70·70
Iron	—	0·52
Arsenic . . .	28·36	23·29
Sulphur . . .	—	3·87

Occurs reniform, botryoidal, massive, and disseminated with cuprite and arseniates of oxide of copper, in veins in the porphyritic mountain of Calabazo in the province of Coquimbo in Peru, in the silver veins of San Antonio not far from Copiapo in Chile, with silver, copper, polybasite, calcite, intimately mixed with bornite.

SELENIDES.

39. **BERZELINE.**—Seleniuret of copper ; Phillips. Berzeline ; Beudant. Selenkupfer ; Mohs, Hausmann. Berzelin ; Haidinger.

Crystalline. Lustre metallic. Silver-white. Streak shining. Soft and malleable. When isolated and rubbed, acquires resinous electricity.

In the open tube selenium and selenic acid sublime, leaving a residue of copper. Emits a strong smell of selenium before the blowpipe, and melts into a grey, rather malleable bead. After long-continued roasting, with soda, yields a globule of copper.

Cu^2Se, copper 61·52, selenium 38·48.

Analysis by Berzelius:—

Copper	64
Selenium	40

Was found as an extremely thin dendritic coating, on calcite, in the copper mine of Skrickerum, in Smaland, in Sweden.

40. **EUKAIRITE.**—Seleniuret of silver and copper; Phillips. Eukairite; Dufrénoy. Eukairit; Mohs, Hausmann, Haidinger.

Crystalline. Opaque. Lustre metallic. Lead-grey. Streak shining. Soft.

In the matrass yields a sublimate of selenium and selenic acid. Before the blowpipe emits a smell of selenium, and melts easily into a grey, metallic globule. With borax and salt of phosphorus yields the reaction of copper, leaving a grey brittle globule of seleniuret of silver. By cupellation yields a globule of silver. Soluble in hot nitric acid.

$Cu^2Se + AgSe$, silver 43·08, copper 25·29, selenium 31·63.

Analysis by Berzelius:—

Silver	38·93
Copper	23·05
Selenium	26·00
Earthy matter . . .	8·90

Was found in cleavable grains in a copper mine, now forsaken, at Skrikerum in the parish of Tryserum in Smaland, with copper and calcite in serpentine.

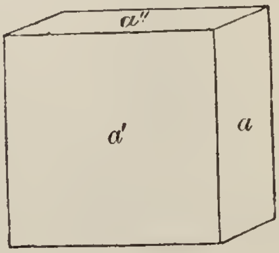
41. **NAUMANNITE.**—Seleniuret of silver; Phillips. Argent séléniuré; Dufrénoy. Selensilber; Mohs, Hausmann. Naumannit; Haidinger.

Cubic.

a 100 cleavage.

aa′ 90° 0′.

FIG. 137.



Cleavage. *a*, very perfect. Opaque. Lustre metallic. Iron-black. Streak the same. Malleable. H = 2·5. G = 8·0.

In the matrass melts and yields a slight sublimate of selenium and selenious acid. Melts before the blowpipe. With soda and borax yields a globule of silver. Easily soluble in fuming nitric acid; with great difficulty in dilute nitric acid.

AgSe, silver 73·15, selenium 26·85.

Analysis by G. Rose:—

Silver	65·56
Lead	4·91
Selenium	25·93

In thin plates, having a crystalline structure.

Is found at Tilkerode in the Harz, with clausthalite in narrow veins in diabase.

42. CLAUSTHALITE. — Seleniuret of lead; Phillips. Clausthalie; Beudant. Selenblei; Mohs, Hausmann. Clausthalit; Haidinger.

Cubic.

a 100 cleavage.

aa′ 90° 0′. (fig. 137.)

Cleavage. *a*. Opaque. Lustre metallic. Lead-grey. Streak grey. Sectile. H = 2·5...3·0. G = 8·2...8·8.

In the matrass decrepitates violently. The varieties containing cobalt yield a sublimate of selenium. In the open tube deposits a sublimate of selenium, partly red, partly grey. Before the blowpipe on charcoal fumes, emits a smell of selenium, deposits a red, yellow, and white sublimate, and imparts a blue colour to the flame; does not melt, but becomes rounded, and is gradually dissipated, leaving a black slag, which, with borax, affords the reactions of iron, copper, and sometimes of cobalt. Partially soluble in nitric acid, leaving a residue of selenium.

PbSe, lead 72·31, selenium 27.69.

Some varieties contain selenide of silver, others selenide of cobalt.

Analyses of Clausthalite *a* from Tilkerode, by H. Rose; *b* from the Lorenz Gegentrum mine near Clausthal, by Stromeyer; *c* from Clausthal, by Stromeyer; *d* from Tilkerode, by Rammelsberg:—

	a	*b*	*c*	*d*
Lead . .	71·81	63·92	70·98	60·15
Silver . .	—	—	—	11·67
Cobalt . .	—	3·14	0·83	—
Iron . .	—	0·45	—	—
Selenium .	27·59	31·42	28·11	26·52

In granular masses, exhibiting cubic cleavages, compact and disseminated.

Is found at Tilkerode, Zorge, Lerbach and Clausthal in the Harz, at Reinsberg near Freiberg in Saxony.

43. LERBACHITE.—Seleniure de plomb et de mercure; Dufrénoy. Selenquecksilberblei; Mohs, Hausmann, Haidinger.

Cubic.

Cleavable in three directions making right angles with each other. Opaque. Lustre metallic. Lead-grey, inclining to steel-grey and iron-black. Streak black. Sectile. Soft. G = 7·3.

Decrepitates when heated. In the matrass yields a grey sublimate of seleniuret of mercury; with soda, a sublimate of mercury. In the open tube yields a liquid sublimate of seleniate of oxide of mercury.

A mixture of PbSe and HgSe in variable proportions.

Analyses of Lerbachite from Tilkerode, by H. Rose:—

Lead . . .	55·84	27·33
Mercury . . .	16·94	44·69
Selenium . . .	24·97	27·98

In crystalline granular masses, and disseminated.

Is found, under the same circumstances as Clausthalite, at Lerbach and Tilkerode in the Harz.

44. ZORGITE.—Seleniure de plomb et de cuivre; Dufrénoy. Selenkupferblei; Mohs, Hausmann, Haidinger.

Fracture conchoidal...uneven. Opaque. Lustre metallic. Light lead-grey, brass-yellow; acquires a blue tarnish. Streak darker than the colour. Malleable. H = 2·5. G = 7·0...7·5.

Before the blowpipe on charcoal melts and deposits a red, white, and yellow sublimate like clausthalite, leaving a slag which yields the reaction of copper.

PbSe with a variable quantity of CuSe or Cu^2Se.

Analyses of zorgite *a*, *b* from Tilkerode, by H. Rose, *c*, *d* from Glasbach, by Kersten:—

	a	*b*	*c*	*d*
Lead . .	59·67	47·33	56·31	64·17
Copper . .	7·86	15·46	8·40	4·08
Silver . .	—	1·29	0·05	0·07
Iron . .	0·33	—	—	trace
Selenium .	29·96	34·26	31·44	29·98
Iron, lead, &c.	0·44	2·08	2·10	—

Is found in granular masses at Tilkerode and Zorge in the Harz, under the same circumstances as Clausthalite, in the Friedrichsglück mine in Glasbachgrund near Gabel in Thuringia, in a vein in clay slate.

45. RIOLITE.—Riolith; Haidinger.

Rhombohedral.

Lead-grey. Very malleable.

$AgSe^2$, silver 57·66, selenium 42·34, according to Del Rio.

Is found in small six-sided tables, with rounded edges and angles, at Tasco in Mexico.

46. ONOFRITE.—Selenschwefelquecksilber; Hausmann. Onofrit; Haidinger.

Lustre metallic. Blackish lead-grey. Streak shining. Sectile. H = 2·5.

In the matrass sublimes undecomposed as a black powder; with soda yields metallic mercury. Before the blowpipe emits the smell of sulphurous acid.

$HgSe,HgS$, a mixture of seleniuret and sulphuret of mercury.

Analysis by H. Rose :—

Mercury	81·33
Sulphur	10·30
Selenium	6·49

Is found massive in veins with mercury, quartz, calcite, baryte, at San Onofre in Mexico.

We quote the descriptions of onofrite and riolite as they are given by Haidinger; but we entertain considerable doubt of their correctness. Mr. Brooke has specimens of a metallic looking mineral said to have been found in the Culebras mine, and described by Del Rio in a letter to Mr. Brooke as 'native selenium with some admixtures,' and to which Mr. Brooke, many years since, gave the name of riolite. Being desirous of ascertaining the difference between this mineral and onofrite, he obtained a specimen under this latter name from Mr. Krantz, which so perfectly resembles that referred to by Del Rio, as to leave no doubt of its being the same mineral, and from the same mine.

The riolite of Haidinger, from Tasco, is described apparently on the authority of Del Rio; but it does not appear from what work that authority is quoted; and as no such compound is alluded to in any of Del Rio's letters to Mr. Brooke, we apprehend that there is some uncertainty with regard to it.

The mineral named culebrite by Mr. Brooke is a dark reddish-brown earthy substance, occurring in small thin veins with the riolite from Culebras, and in one of Del Rio's letters is stated to be 'sulphuret of mercury with native selenium, but not combined,' a description which may probably require to be corrected.

SULPHIDES.

47. **GALENA.**—Galena; Phillips. Plomb sulfuré; Hauy. Hexaedrischer Blei-Glanz; Mohs. Bleiglanz; Hausmann. Glanz; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *n* 211, *m* 311, *p* 122, *q* 133.

aa′	90° 0′	*do*	35° 16′	*pa*	70° 32′
oo′	70 32	*na*	35 16	*po*	15 48
dd′	60 0	*ma*	25 14	*qa*	76 44
oa	54 44	*no*	19 28	*qo*	22 0
da	45 0	*mo*	29 30		

FIG. 138.

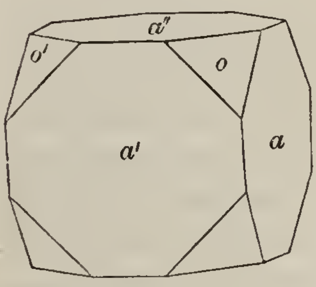


FIG. 139.

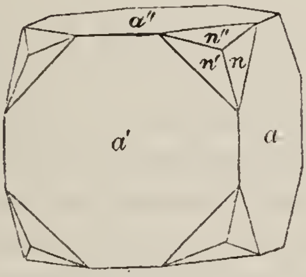


FIG. 140.

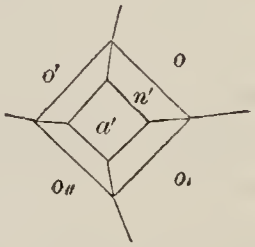


FIG. 141.

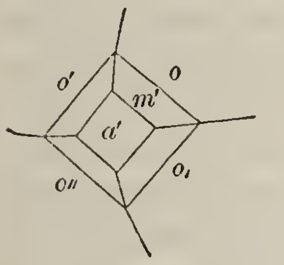


FIG. 142.

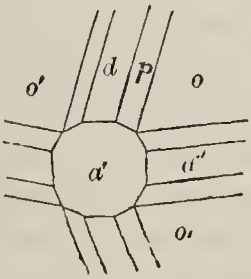
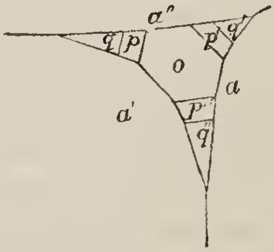


FIG. 143.



Forms and combinations. *a, o, ao, an, aod, aon, aom, aodp, aopq*. Twins. Twin-face *o*. Frequently very thin in a direction perpendicular to the twin-face. Cleavage. *a*, very perfect and easily obtained. Fracture conchoidal, seldom observable.

Opaque. Lustre metallic. Lead-grey; occasionally tarnished. Streak the same. Rather sectile. H = 2·5. G = 7·4...7·6.

Decrepitates when heated. In the open tube yields a sublimate of sulphur and sulphate of oxide of lead. Before the blowpipe on charcoal melts, and, after the sulphur is driven off, is reduced to a bead of lead, which, by cupellation, frequently yields a globule of silver. Partially soluble in nitric acid with evolution of nitrous acid and separation of sulphur.

PbS, lead 86·58, sulphur 13·42.

Analyses of galena *a* by Thomson, *b* from Inverkeithing, by Robertson, of a variety containing zinc from Przibram, *c* (G = 7·252), *d* (G = 7·324), both by Lerch:—

	a	*b*	*c*	*d*
Lead . .	85·13	84·63	81·80	83·61
Iron . .	0·50	zinc	3·59	2·18
Sulphur . .	13·02	13·21	14·41	14·18

Galena frequently contains a small quantity of sulphide of silver, amounting usually to 0·01 or 0·03 per cent., occasionally to 0·5, and rarely to 1 per cent. Some varieties contain selenide of lead, some also traces of gold, antimony, and arsenic.

In attached, and sometimes in imbedded crystals; but usually in granular masses and disseminated, pseudomorphous after pyromorphite.

Occurs very abundantly in rocks of the most different formations, in beds associated with calamine, brown iron oxide, pyrite, towanite, blende, quartz, baryte, amphibole; in veins with ores of silver, copper, iron, antimony, with gold, silver, arsenic, sulphur, &c. Is found in veins in the mining districts of Saxony and Bohemia, the Harz, Hungary, Transylvania, France, Konsberg in Norway, Siberia, Sahla and Fahlun in Sweden; in Spain at Linares in granite and in the Sierra de Gador in the Alpujarras in dolomite, at Bleyberg and Windishkappel in Carinthia in limestone, Tarnowitz in Silesia, Stiria, Missouri and other places in North America, in Greenland with cryolite and chalybite, in Cumberland, Durham, Northumberland, Derbyshire and Flintshire in veins in limestone, in several mines in Cornwall and Devonshire in veins in clay slate, in Shropshire and most of the counties of Wales in slate, the Lead Hills in Lanarkshire, Wanlockhead in Dumfriesshire, Monaltrie in Aberdeenshire in granite, Strontian in Argyleshire in gneiss, Cumberhead in Lanarkshire, in the Lothians and Fifeshire in the sandstones of the coal formation, in limestone in Isla, in gneiss in Coll. The varieties containing selenium are found at Clausthal and Tilkerode in the Harz and at Fahlun in Sweden. Pseudomorphous after pyromorphite at Tschopau in Saxony, Poullaoeun in France and Wheal Hope in Cornwall. Crystallizes from fusion in cubes.

According to Naumann, the forms 433, 144, 455, 477, 611, 12 1 1 have been observed in galena.

48. ARGENTITE.—Sulphuret of Silver; Phillips. Argent sulphuré; Hauy. Hexaedrischer Silber-Glanz; Mohs. Silberglanz; Hausmann. Argentit; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *n* 211, *p* 122.

aa′	90°	0′	*da′*	45°	0′	*nn′*	33°	33′
oo′	70	32	*do*	35	16	*pa*	70	32
oa	54	44	*na*	35	16	*po*	15	48
dd′	60	0	*no*	19	28			

FIG. 144.

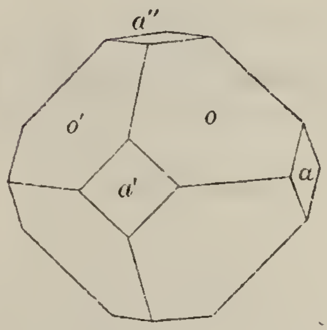


FIG. 145.

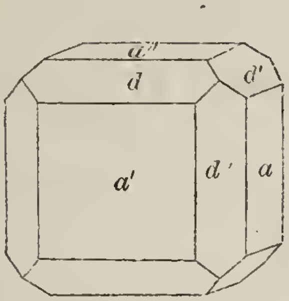
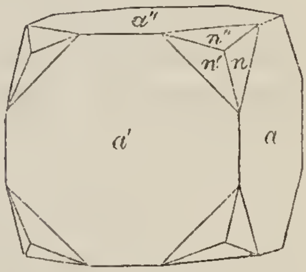


FIG. 146.



Forms and combinations. *a, o, d, n, ao, ad, an, aodn.* Surfaces uneven, dull. Cleavage. *a, d,* traces. Fracture uneven, hackly. Opaque. Lustre metallic. Blackish lead-grey. Streak shining. Malleable. H = 2·0…2·5. G = 7·196.

Before the blowpipe on charcoal intumesces, melts with disengagement of sulphurous acid, and at last yields a globule of silver. Soluble, with the exception of the sulphur, in concentrated nitric acid.

AgS, silver 87·05, sulphur 12·95.

Analyses of argentite from Freiberg and from Joachimsthal, by Klaproth:—

Silver	86·50	86·39
Sulphur . . .	13·50	13·61

The crystals either attached singly or united in druses, usually bent and distorted, dendritic, capillary, compact, disseminated, investing other minerals, earthy (black sulphuret of silver).

Occurs in veins in gneiss, mica slate, hornblende slate, clay slate, granite, porphyry, trachyte, with arsenic, silver, stephanite, pyrargyrite, proustite, galena, quartz, calcite, dolomite, baryte, fluor. Is found at Freiberg, Schneeberg, Annaberg, Marienberg and Johan-Georgenstadt in Saxony, Kongsberg in Norway, Joachimsthal and Przibram in Bohemia, Schemnitz and Kremnitz in Hungary, Schwatz in the Tyrol, Wolfach in Baden, Andreasberg in the Harz, Guadalcanal in Spain, Sardinia, Chalanches near Allemont in Dauphiné; the Kolywan mountains in Siberia, Guanaxuato and Zacatécas in Mexico, Peru, in Cornwall, in cubes and massive in Herland, Huel Duchy, in cubes in Huel St. Vincent near Callington, in Huel Basset and Dolcoath.

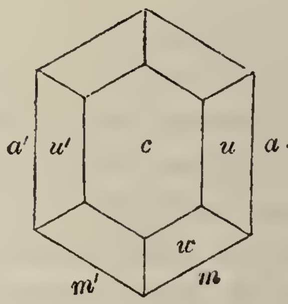
49. **STROMEYERITE.**—Sulphuret of silver and copper; Phillips. Stromeyerine; Beudant. Isometrischer Kupfer-Glanz; Mohs. Silberkupferglanz; Hausmann. Stromeyerit; Haidinger.

Prismatic. Isomorphous with redruthite.

a 100, *c* 001, *u* 102, *v* 112 twin-plane, *w* 114. *v* truncates the edge *wm*.

uc	25°	53′
ac	90	0
mm′	60	25
wa	77	23
wc	25	44
vc	43	57
mc	90	0
uu′	51	46

FIG. 147.



Combination. *mwuac*. Twins. 1. Twin-face *m*. 2. Twin-face *v*. Fracture conchoidal. Opaque. Lustre metallic. Blackish lead-grey. Streak the same, shining. Perfectly sectile. H = 2·5...3·0. G = 6·255.

Before the blowpipe fuses readily into a grey metallic globule, which with fluxes affords the reaction of copper, and by cupellation yields a globule of silver. Partially soluble in nitric acid, leaving sulphur undissolved.

$Cu^2S + AgS$, silver, 53·13; copper, 31·17; sulphur, 18·70.

Analyses of stromeyerite *a* from Schlangenberg, by Stromeyer; *b* from Rudelstadt by Sander; of mixtures of stromeyerite and redruthite *c* from San Pedro in Chile; *d, e, f* from Catemo in Chile, all by Domeyko:—

	a	*b*	*c*	*d*	*e*	*f*
Copper . .	30·48	30·95	53·38	53·94	60·58	63·98
Silver . .	52·27	52·71	28·79	24·04	16·58	12·08
Iron . .	0·33	0·24	—	2·09	2·31	2·53
Sulphur . .	15·78	15·92	17·83	19·93	20·53	21·41

In crystals, usually massive and disseminated.

Is found in crystals at Rudelstadt in Silesia, massive at Schlangenberg in Siberia, mixed in various proportions with redruthite at Catemo near San Felipe de Aconcagna and San Pedro Nolasco in Chile. A variety from Freiberg, according to Lampadius, contains 18·5 per cent. of sulphide of silver.

The isomorphism of stromeyerite, $Cu^2S + AgS$, and redruthite, Cu^2S, is an indication that AgS is isomorphous with Cu^2S. But argentite belongs to the cubic system. Hence probably AgS is isodimorphous with Cu^2S.

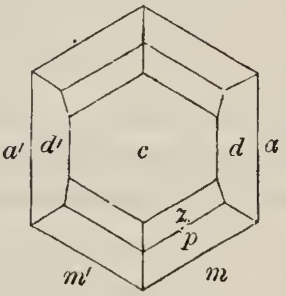
50. REDRUTHITE.—Vitreous copper; Phillips. Cuivre sulphuré; Hauy. Prismatischer Kupfer-Glanz; Mohs. Kupfer-Glanz; Hausmann, Haidinger.

Prismatic. 011,010=30° 57′; 101,001=44° 8′; 110,100=59° 47′·5.

a 100, *b* 010, *c* 001, *e* 203, *d* 201, *m* 110, *n* 320, *p* 111, *v* 112, *z* 113. *b* truncates the edge *mm′*, *e* truncates the edge *cd*, *n* truncates the edge *am*, *v* truncates the edge *zp*.

ec	32° 54′	*pc*	62° 36′		
dc	62 44	*mc*	90 0		
ac	90 0	*za*	74 13		
dd′	125 28	*va*	69 59		
na	48 52	*pa*	63 28		
ma	59 48	*pp′*	53 4		
mm′	60 25	*zb*	62 9		
zc	32 44	*vb*	53 9		
vc	43 57	*pb*	39 53		

FIG. 148.



Combinations. *mac*, *bmac*, *zec*, *mpdac*, *mpndac*, *mpzeac*, *bmpdeac*, *mpzndeac*. The faces *c* striated parallel to their intersections with *a*. Twins. 1. Twin-face *m*. 2. Twin-face *v*. Cleavage. *m*, traces. Fracture conchoidal. Opaque. Lustre metallic. Blackish lead-grey, sometimes iridescent. Streak the same, shining. Very sectile. H = 2·5...3·0. G = 5·5...5·8.

Before the blowpipe on charcoal imparts a blue colour to the flame; in the outer flame melts easily with effervescence; in the inner flame becomes solid. With soda yields a globule of copper. Is completely decomposed by warm nitric acid, yielding a blue solution, and leaving a residue of sulphur.

Cu^2S, copper 79·84, sulphur 20·16.

Analyses of redruthite *a* from the Gumeschefskoi mine, near Katharinenburg, by Klaproth; *b* from Siegen, by Ullmann; *c* from the United mines in Cornwall, by Thomson; *d* from Byglands Grube, *e* from Strömsheien in Norway, both by Scheerer; *f* from San Pedro in Chile, by Domeyko:—

	a	*b*	*c*	*d*	*e*	*f*
Copper . .	78·50	79·50	77·16	77·76	79·12	75·51
Iron . .	2·25	0·75	1·45	0·91	0·28	0·74
Sulphur . .	18·50	19·00	20·62	20·43	20·36	20·79
Silica . .	0·75	1·00	—	—	Silver	2·96

In crystals, attached singly, or collected in druses; usually massive and disseminated.

Occurs in beds and veins with bornite, pyrite, chrysocolla, malachite, chessylite, quartz. Is found near Freiberg in veins; in Mansfeld and Hessia disseminated in beds in bituminous copper slate; in Siegen in veins of iron stone; at Kupferberg and Rudelstadt in Silesia, Moschellandsberg, at Lauterberg in the Harz, in Sweden, Norway, Siberia, the Banat of Temeswar, North America, Peru, Guanaxúato in Mexico. Crystallized and massive in veins in clay slate in several mines near Redruth and the Land's End in Cornwall, at Middleton Tyas in Yorkshire; in veins at Fassney Burn in East Lothian, and in Ayrshire in Scotland, in Fair Isle between the Orkney and Shetland Isles.

By fusing copper glance, or a mixture of copper and sulphur in the same proportions, $\overset{\prime}{\not{\mathrm{C}}\mathrm{u}}$ can be obtained in octahedral crystals, and is consequently dimorphous.

The characters of Breithaupt's digenite appear to be the same as those of redruthite, except that G = 4·568...4·680. According to a quantitative blowpipe analysis by Plattner, it consists of—copper 70·20, silver 0·24, sulphur 29·66.

It occurs massive, and investing other minerals with crystallized redruthite, at Sangerhausen, and with cuproplumbite in Chile.

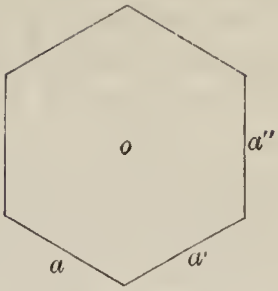
51. COVELLINE. — Covelline; Beudant. Kupferindig, Mohs, Hausmann. Covellin; Haidinger.

Rhombohedral.

o 111, *a* $01\bar{1}$.

ao	90°	0′
aa′	60	0

FIG. 149.



Combination. *oa.* The faces *a* striated parallel to their intersections with *o*. Cleavage. *o* very perfect. Opaque. Lustre resinous, inclining to metallic. Indigo blue. Streak black, shining. Sectile. In thin leaves flexible. H = 1·5...2·0. G = 3·80...3·82.

CuS, copper 66·44, sulphur 33·56.

Analyses of covelline *a* from Badenweiler by Walchner, *b* from Vesuvius by Covelli:—

	a	*b*
Copper	64·77	66·0
Iron	0·46	—
Lead	1·05	—
Sulphur	32·64	32·0

Before the blowpipe burns with a blue flame. Melts with ebullition into a globule which with soda yields a bead of copper. Soluble in nitric acid.

In crystals, massive, reniform, investing other minerals.

Is found in the kupferschiefer at Sangerhausen in Thuringia; in the Hausbaden mine near Badenweiler with redruthite and towanite; in the Herrenseegen mine at Schapbach in the Black Forest with towanite, at Kielce in Poland, crystallized with calcite in clay slate at Leogang in Salzburg, in the crater of Vesuvius.

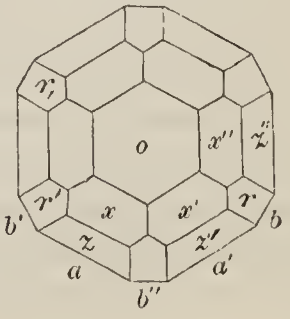
52. PYRRHOTINE.—Magnetic iron pyrites; Phillips. Fer sulfuré magnetique; Hauy. Rhomboedrischer Eisen-Kies; Mohs. Magnetkies; Hausmann. Pyrrhotin; Haidinger.

Rhombohedral. 100,111 = 60° 7′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *r* 100, $r_{,}$ $\bar{1}22$, *x* 120, *z* $13\bar{1}$.

ao	90°	0′	*xo*	44°	44′
aa′	60	0	*zo*	63	25
ba′	30	0	*xx′*	41	12
ro	60	7	*xx″*	75	6
$or_{,}$	60	7	*zz′*	53	8
rr′	97	20	*zz″*	101	32
$r'r_{,}$	51	23			

FIG. 150.



Combinations. *ob*, *oz*, *oaz*, *oabxzrr*$_{,}$. Cleavage. *o*, perfect; *b* less distinct. Fracture conchoidal, small and imperfect. Opaque. Lustre metallic. Brass-yellow, inclining to copper-red; acquires a tarnish. Streak greyish-black. Feebly magnetic. Brittle. H = 3·5...4·5. G = 4·6...4·7.

In the matrass unchanged. In the open tube yields sulphurous acid, but no sublimate. Before the blowpipe on charcoal in the inner flame melts into a greyish-black highly magnetic bead. Soluble in hydrochloric acid with evolution of hydrosulphuric acid, and leaving a residue of sulphur.

$\overset{\prime}{\mathrm{F}}\mathrm{e}^{5}\overset{\prime\prime\prime}{\mathrm{F}\!\!\!-}\mathrm{e}$, iron 60·49, sulphur 39·51.

Analyses of pyrrhotine *a* from Treseburg; *b* from Barèges, by Stromeyer; *c* from Congonhas do Campo; *d* from Fahlun, by Plattner; *e* a very magnetic variety; *f* less magnetic, from the Lalliat mountain near Sion in the Valais, by Berthier; *g* from Bodenmais, by H. Rose; *h* from Modum, by Scheerer; *i* from Klefva in Smaland, by Berzelius; *k* from Rajpootanah, by Middleton:—

	a	*b*	*c*	*d*	*e*	*f*
Iron . . .	59·29	56·38	59·61	59·72	59·8	61
Sulphur . .	40·71	43·62	40·43	40·22	40·2	39

	g	*h*	*i*	*k*
Iron . . .	61·02	56·03	57·91	62·27
Nickel . .	—	2·80	3·05	—
Cobalt . .	—	—	0·09	—
Manganese .	—	—	0·22	—
Copper . .	—	0·40	0·45	—
Sulphur . .	39·10	40·46	38·27	37·73

Very seldom distinctly crystallized; usually massive and disseminated.

Occurs principally in beds in the older rocks, with magnetite, iron and copper pyrites, blende; seldom in veins with silver, pyrargyrite, arsenic, galena, calcite, quartz; in various meteorites. Is found in veins with silver at Kongsberg in Norway and Andreasberg in the Harz, well crystallized; in veins in diorite and slate at Treseburg and Thale in the Harz; in beds at Bodenmais in Bavaria, Breitenbrunn and Geyer in Saxony, Querbach and Gieren in Silesia, Auerbach in Baden, Valsugana in the Tyrol, Fahlun in Sweden, Wezelakow in Bohemia, Zoppons in Moravia, Obedach in Stiria, at the base of Moel Elion in Cærnarvonshire; disseminated in granite and greenstone at Barèges, Bagnères de Luchon, the Maladetta in the Pyrenees, Nantes in France; at Appin in Argyleshire, and in some of the hills of Galloway in Scotland; Congonhas do Campo in the

Brazils; in crystals in the meteorites which fell at Juvenas in France, Klein Wenden, Chateau Renard and Richmond in Virginia, in the meteoric iron of Elbogen, Bohumilitz and Scriba.

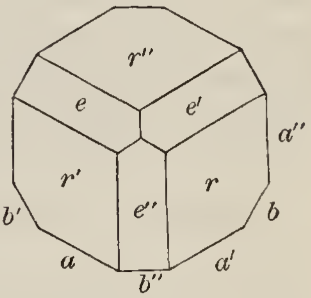
53. MILLERITE.—Native nickel; Phillips. Nickel natif; Hauy. Haarkies; Mohs. Nickelkies; Hausmann. Millerit; Haidinger.

Rhombohedral. 100,111 = 20° 50′.

a $01\bar{1}$, b $2\bar{1}\bar{1}$, k $5\bar{1}\bar{4}$, t $\bar{5}44$, r 100 cleavage, $r_{,}$ $\bar{1}22$ cleavage, e 011 cleavage, $e_{,}$ 411 cleavage. t'' truncates the edge $e''b''$.

kb	19°	16′	tb	138°	47′
ba'	30	0	rb''	79	45
bb''	60	0	eb'	84	39
aa'	60	0	ra'	72	4
rb	69	10	ae''	80	41
$be_{,}$	79	14	rr'	35	52
eb	100	46	ee'	18	38
$br_{,}$	110	50			

FIG. 151.



The alternate faces b are frequently very narrow. Cleavage. r, $r_{,}$, e, $e_{,}$, all very perfect. Opaque. Lustre metallic. Brass-yellow, inclining to bronze-yellow. Streak bright. H = 3·5. G = 5·26...5·30.

In the open tube yields sulphurous acid. Before the blowpipe melts readily into a black magnetic globule. Imparts to borax the colour of nickel. With nitromuriatic acid yields a green solution.

$\dot{\mathrm{Ni}}\mathrm{S}$, nickel 64·86, sulphur 35·14.

Analyses of millerite from Camsdorf *a* by Rammelsberg, *b* by Arfvedson, *c* from the Friedrichszeche near Oberlahr, by Schnabel:—

	a	*b*	*c*
Nickel . . .	61·34	64·35	64·80
Iron	1·73	—	—
Copper . . .	1·14	—	—
Sulphur . . .	35·79	34·26	35·03

In very delicate capillary and acicular attached crystals.

Is found at Johanngeorgenstadt in Saxony, Joachimstal and Przibram in Bohemia, Camsdorf in Thuringia, Riechelsdorf in Hessia, in the Westerwald, Cornwall, Merthyr Tydvil in Glamorganshire in nodules of chalybite.

It is not improbable that the faces $r_{,}$, $e_{,}$ may belong to one of the individuals of a twin-crystal, and r, e to the other. On account of the extreme slenderness of the crystals in which the faces $r_{,}$, $e_{,}$ were observed, it has not been found possible to verify this conjecture.

54. EISENNICKELKIES.—Eisennickelkies; Hausmann.

Cubic.

Cleavage apparently parallel to the faces of an octahedron. Fracture uneven. Opaque. Lustre metallic. Light pinchbeck-brown. Streak rather darker. Brittle. H = 3·5...4·0. G = 4·6. Not magnetic.

Chemical characters the same as those of pyrrhotine, except that when fused with borax in the inner flame, after being roasted, the bead becomes black and opaque in consequence of the reduction of the nickel.

$2FeS + NiS$, iron 41·04, nickel 22·11, sulphur 35·95.

Analysis by Scheerer:—

Iron . . .	40·21
Nickel . .	21·07
Copper . .	1·78
Sulphur . .	36·64

Is found in crystalline masses with towanite, in greenish-black amphibole, near Lillehammer in Norway.

55. GREENOCKITE. — Cadmium sulfuré; Dufrénoy. Greenockit; Hausmann, Haidinger.

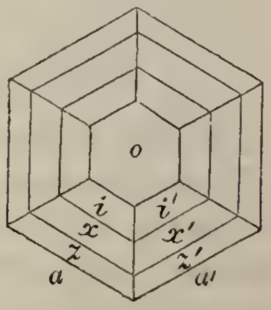
Rhombohedral. 100,111 = 58° 47′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *i* 231, *x* 120, *z* $13\bar{1}$, *v* $15\bar{3}$.

b″ truncates the edge *aa′*; *v* truncates the edge *za*. The forms *i*, *x*, *z*, *v* are frequently hemihedral with inclined faces.

ao	90°	0′	*zo*	62°	18′
aa′	60	0	*vo*	75	18
ab″	30	0	*ii′*	24	32
io	25	28	*xx′*	40	22
xo	43	37	*zz′*	52	33

FIG. 152.



Combinations. *axz*, *oaxz*, *oax′z′*, *oaix′z′*, *oax′z′v′*, *oaix′z′v′*. Cleavage. *o*, *a*. Translucent...semi-transparent. Lustre adamantine, inclining to resinous. $\mu = 2{\cdot}688$. μ' very nearly the same. Spheroidal wave surface oblate. Honey-yellow...orange-yellow, seldom brown. Streak reddish orange-yellow. H = 3·5. G = 4.8...4·9.

In the matrass decrepitates and turns red, reassuming its yellow colour on cooling. Before the blowpipe on charcoal with soda deposits a reddish-brown sublimate on the charcoal. Soluble in warm hydrochloric acid with evolution of hydrosulphuric acid.

CdS, cadmium 77·70, sulphur 22·30.

Analyses by Connel and Thomson:—

Cadmium	77·30	77·6
Sulphur	22·56	22·4

Occurs in attached crystals at Bishopton in Renfrewshire, in a porphyritic amygdaloidal trap containing crystals of felspar, calcite, and prehnite in its cavities.

56. **BLENDE.**—Blende; Phillips. Zinc sulfuré; Hauy. Dodekaedrische Granat Blende; Mohs. Zinkblende; Hausmann. Blende; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *g* 023, *m* 311, *p* 122. The forms *o*, *m*, *p* are usually hemihedral with inclined faces.

aa'	90°	0′	do	35°	16′	ma	25°	14′
oo'	70	32	ga'	33	41	mo	29	30
$oo_{,,}$	109	28	gd	11	19	md'	31	29
oa	54	44	na	35	16	pa	70	32
dd'	60	0	no	19	28	po	15	48
da'	45	0	nd'	30	0	pd	19	28

FIG. 153.

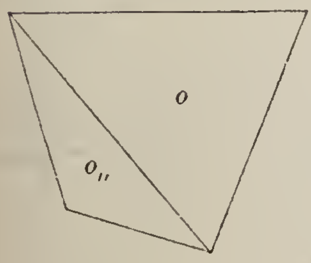


FIG. 154.

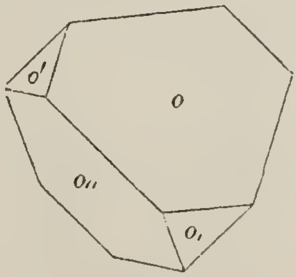


FIG. 155.

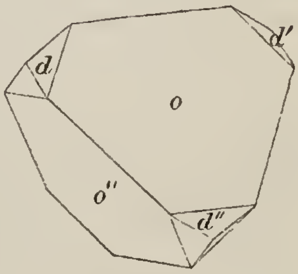


FIG. 156.

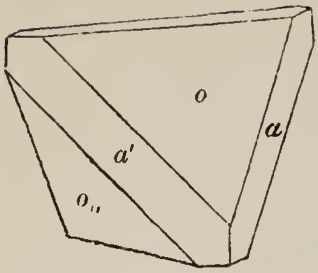


FIG. 157.

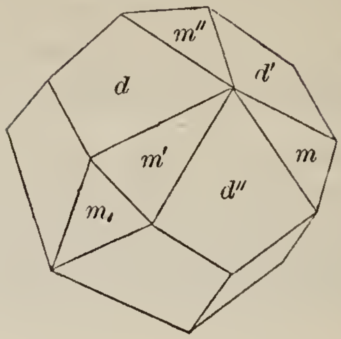
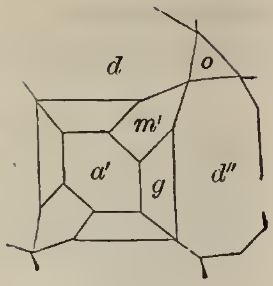


FIG. 158.



Forms and combinations. *a, o′, m′, ao′, o′o‵, am′, o‵m′, dm′, ao′o‵, do′o‵, aod, do‵m′, adm′, do′o‵p′, ado‵p‵m′, ao‵o′dgm′.*

Twins. Twin-face *o*. Cleavage. *d*, very perfect. Fracture conchoidal. Transparent...opaque. Lustre adamantine. Green, yellow, red, brown, black. Streak white...reddish-brown. Brittle. H = 3·5...4·0. G = 3·9...4·2. Conducts electricity very imperfectly.

Decrepitates violently when heated. Before the blowpipe on charcoal is fusible with difficulty on the edges. When strongly heated in the outer flame deposits an areola of oxide of zinc round the assay. With soda is reduced. In powder soluble, with the exception of the sulphur, in concentrated nitric acid.

ZnS, zinc 67·03, sulphur 32·97.

Analyses of blende *a*, *b* fibrous, from Przibram, by Löwe; *c* by Arfvedson; *d* of a colourless transparent variety (G = 4·063) from New Jersey (Nuttall's cleiophane), by T. H. Henry; *e* from Bagnères de Luchon by Berthier; *f* from Chéronies in the department of Charente, by Lecanu:—

	a	*b*	*c*	*d*	*e*	*f*
Zinc . .	61·40	62·62	66·34	67·46	63·0	55·0
Iron . .	2·29	2·20	—	—	3·4	8·6
Cadmium .	1·50	1·78	—	trace	—	—
Sulphur .	33·15	32·72	33·66	32·22	33·6	36·2

Analyses of blende *g* from Raibel in Carinthia, by Kersten; *h* from Eaton, *i* from Lyman, and *k* from Shelburne in New Hampshire, all by Jackson; *l* fibrous, from England, by Berthier; *m* from Christiania, by Scheerer:—

	g	*h*	*i*	*k*	*l*	*m*
Zinc . . .	64·22	63·62	55·6	52·0	61·5	53·17
Iron . . .	1·32	3·10	8·4	10·0	4·0	11·79
Cadmium .	trace	0·6	2·3	3·2	—	—
Sb,Pb,O . .	0·72	manganese		1·3	—	0·74

	g	h	i	k	l	m
Sulphur . .	32·10	33·22	33·4	32·6	33·0	33·73
Water . .	0·80	—	earthy matter		1·5	—

According to Boussingault black varieties of blende (marmatite) from Candado and Salto near Marmato not far from Popayan, consist respectively of:—

Sulphide of zinc	77·5	76·8
Sulphide of iron	22·5	23·2

In attached crystals, granular and fibrous masses, botryoidal. Is very widely diffused, in veins and beds, especially in crystalline slate and transition rocks with galena, pyrite, towanite, in veins, with ores of silver and arseniurets.

Is found at Schemnitz in Hungary, Kapnik in Transylvania, Przibram in Bohemia, Raibel in Carinthia, Geroldseck in the Breisgau, Scharfenberg, Schwarzenberg, Freiberg in Saxony, Goslar, Lautenthal, Zellerfeld, Andreasberg and Neudorf in the Harz, Sweden, Derbyshire, Flintshire, St. Agnes in Cornwall, Clifton lead mine near Tyndrum in Perthshire, Lead Hills, in the coal field around Edinburgh, Cumberhead in Lanarkshire. Cleavable masses have been obtained by fusing together zinc and sulphur.

57. ALABANDINE.—Sulphuret of manganese; Phillips. Manganèse sulfuré; Hauy. Hexaedrische Glanz-Blende; Mohs. Manganblende; Hausmann. Alabandin; Haidinger.

Cubic.

a 100, *o* 111, *d* 011 cleavage.

aa′	90°	0′	
oa	54	44	(fig. 138.)
da′	45	0	

Twins. Twin-face *o*. Cleavage. *a*, perfect; *d*, traces. Fracture uneven, imperfect conchoidal. Opaque. Lustre metallic, imperfect. Iron-black...dark steel-grey; acquires a brownish-black tarnish. Streak dark green. Slightly brittle. H = 4·0. G = 3·95...4·014. Does not conduct electricity.

In the matrass unchanged. In the open tube yields sulphurous acid, and becomes greyish-green. Before the blowpipe on charcoal, after previous roasting, melts with difficulty in the inner flame into a brown slag. With borax gives the reaction of manganese. Soluble in salt of phosphorus with copious evolution of a combustible gas. Soluble in hydrochloric acid with evolution of sulphuretted hydrogen.

MnS, manganese 63·27, sulphur 36·73.

Analysis of alabandine from Transylvania, by Arfvedson:—

Manganese . . .	62·10
Sulphur	37·90

In crystals, usually in granular masses.

Is found in veins with nagyagite, blende, pyrite, köhlerite, quartz, at Nagyag in Transylvania, in a vein of quartz at Roçinha da Gama in the province of Minas Geraes in the Brazils, in Mexico.

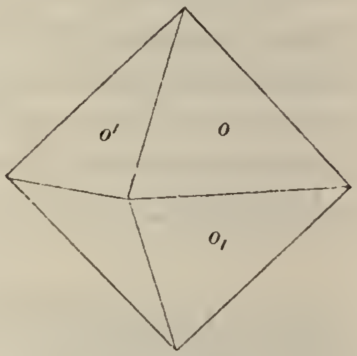
58. HAUERITE.—Hauerit; Hausmann.

Cubic.

a 100, *o* 111, *d* 011, *f* 310, *s* 321. The forms *f*, *s* are hemihedral with parallel faces.

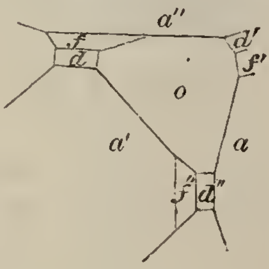
aa′	90°	0′	*f″a′*	18°	26′
oo′	70	32	*fd*	26	34
oa	54	44	*sa′*	36	42
dd′	60	0	*so*	22	13
da′	45	0			

FIG. 159.



Forms and combinations. *o*, *oa*, *os*‵, *oas*‵, *oadf*‵, *oads*‵. Cleavage. *a*, perfect. In very thin plates translucent and brownish-red by transmitted light. Lustre adamantine, inclining to metallic. Dark reddish-brown...brownish-black. Streak brownish-red. H = 4·0. G = 3·463.

FIG. 160.



In the matrass yields a sublimate of sulphur, leaving a green residue which before the blowpipe becomes brown on the surface. After all the sulphuret of manganese is decomposed imparts a violet colour to salt of phosphorus in the outer flame. With soda on platinum foil affords the reaction of manganese.

MnS^2, manganese 46·27, sulphur 53·73.

Analysis by A. Patera:—

Manganese . . .	42·97
Iron	1·30
Sulphur	53·64
Silica	1·20

In crystals and spherical groups of crystals.

Is found in clay with gypsum, and sometimes with sulphur at Kalinka near Végles, not far from Altsohl in Hungary.

59. PYRITE.—Iron pyrites; Phillips. Fer sulfuré; Hauy. Hexaedrischer Eisen-Kies; Mohs. Schwefelkies; Hausmann. Pyrit; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *g* 320, *e* 120, *f* 310, *p* 122, *n* 211, *m* 311, *s* 231, *v* 531, *t* 241, *z* 543. The forms *g, e, f, s, v, t, z* are usually hemihedral with parallel faces.

aa′	90°	0′	*ga*	33°	41′	*mo*	29°	30′
oo′	70	32	*gd″*	11	19	*sa′*	36	42
oa	54	44	*fa*	18	26	*so*	22	13
dd′	60	0	*fd″*	26	34	*ta*	29	12
da′	45	0	*pa*	70	32	*to*	28	8
do	35	16	*po*	15	48	*va*	32	19
ea′	26	34	*na*	35	16	*vo*	28	35
eo	39	44	*no*	19	28	*za*	45	0
ed″	18	26	*ma*	25	14	*zo*	11	32

FIG. 161.

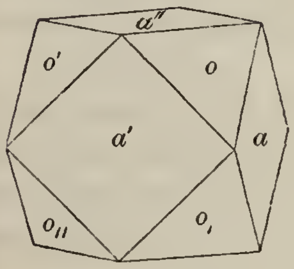


FIG. 162.

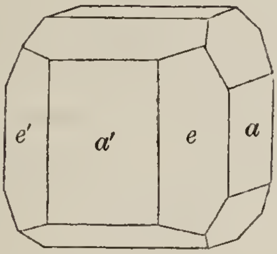


FIG. 163.

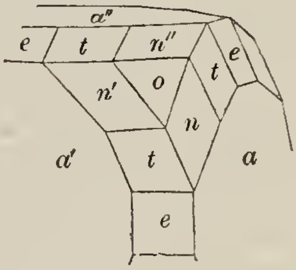


FIG. 164.

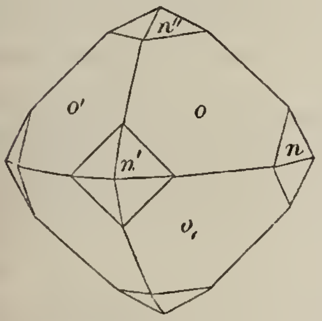


FIG. 165.

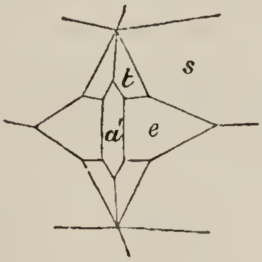
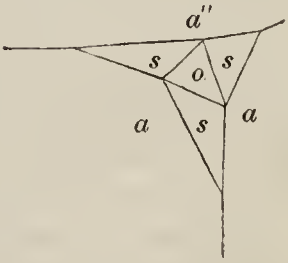


FIG. 166.



Forms and combinations. *a, o, g′, e′, n, s′, ao, ae′, as′, oe, g′e′, e′s′, e′s‵, e′t′, ave′, ode′, ame′, ae′s′, aos′, ae′t′, e′t′s′, aode′, aoe′t′, ode′s′, odps′, adof′, aes′z‵, aoe′s′, ae′t′s′, aoe′nt′, aoe′t′s′, ae′t′s′z‵, aode′n, aode′s′, aoe′g′t′z‵, aog′e′s′v′t′.* The faces *a* usually striated parallel to the edges of *e*‵ which they truncate. *t* sometimes rough. Twins. Twin-face *o*. Cleavage. *a*, *o*. Fracture conchoidal...uneven. Opaque. Lustre metallic. Brass-yellow inclining sometimes to gold-yellow; frequently brown; rarely iridescent. Streak dark greenish-grey. Opaque. Brittle. H = 6·0...6·5. G = 4·9...5·1. When broken emits a smell of sulphur.

In the matrass yields a sublimate of sulphur. Before the blowpipe on charcoal burns with a blue flame, giving out a sulphureous odour, and melts in the inner flame into a blackish magnetic globule, which imparts a bottle-green colour to glass of borax. Partly soluble in nitric acid, leaving a residue of sulphur.

FeS^2, iron 46·67, sulphur 53·33.

Analyses *a* by Hatchett, *b* by Berzelius, *c* from the Philippshoffnung mine near Siegen, *d* from Heinrichssegen near Müsen by Schnabel:—

	a	*b*	*c*	*d*
Iron . . .	47·85	46·08	46·53	46·5
Sulphur . .	52·15	53·92	53·39	53·5

Some varieties contain a small quantity of gold, others silver; some contain traces of silicon and selenium. According to Breithaupt the varieties associated with fluor and baryte contain a small quantity of arsenic. Waldbroel found 0·168 per cent. of nickel in pyrite from Eckerhagen.

In imbedded and attached crystals, united in druses, globular, botryoidal, reniform, in organic forms, filling up the crevices of wood, and in the form of the interior of ammonites, &c.; most frequently massive and disseminated; pseudomorphous after stephanite, pyrargyrite, calcite, baryte.

Is universally diffused, disseminated in rocks, in beds and veins, in the most different formations, and occurs frequently in meteoric stones. Fine crystals are found in Elba, Traversella and Brosso in Piemont, the coal mines near Potschappel near Dresden, the mines of Freiberg, Schneeberg, Johann-Georgenstadt in Saxony, Giftberg near Horzowitz in Bohemia, Schemnitz in Hungary, Kongsberg in Norway, Fahlun in Sweden, Derbyshire, Cornwall, Dauphiné. Auriferous pyrites occur at Aedelfors in Sweden, Beresow in Siberia, Marmato in the province of Popayan in New Granada, and in several places in Mexico.

60. MARCASITE.—White iron pyrites; Phillips. Fer sulphuré blanc; Hauy. Prismatischer Eisen-Kies; Mohs. Wasserkies; Hausmann. Markasit; Haidinger.

Prismatic. 011,010=32° 26′; 101,001=49° 50′; 110,100=53° 2′·5.

c 001, *e* 011, *l* 101, *z* 102, *v* 103, *r* 104, *m* 110, *s* 111. *z*, *v* truncate the edge *lr*.

ec	57°	34′	*lc*	49°	50′	*mc*	90°	0′
ee′	115	8	*ac*	90	0	*sa*	57	35
rc	16	30	*ma*	53	3	*ea*	90	0
vc	21	33	*mm′*	73	55	*sl*	45	27
zc	30	38	*sc*	63	5			

FIG. 167.

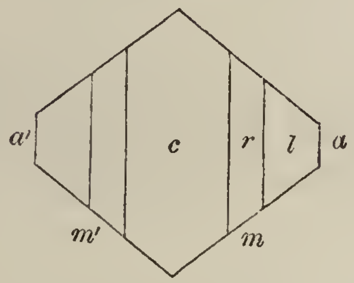
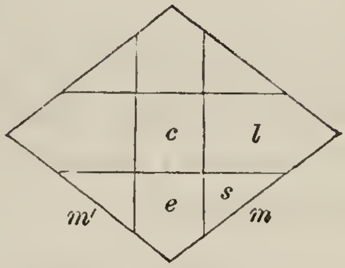


FIG. 168.



Combinations. *el*, *elc*, *mzc*, *emlc*, *mlzc*, *eslc*, *emslc*, *emlzc*, *emslzc*. The faces *e* striated parallel to the intersections with *s*, and usually rough; *z*, *c* striated parallel to their intersections with each other. Twins. 1. Twin-face *m*, *mɯ* = − 32° 10′. 2. Twin-face *e*. *cɔ* = − 64° 52′. The individuals are often united to others according to the former law. Cleavage. *m*, tolerably distinct; *l*, traces. Fracture uneven. Opaque. Lustre metallic. Light brass-yellow, sometimes inclining to green and grey. Occasionally acquires a variegated or brown tarnish. Streak dark greenish-grey. Brittle. H = 6·0...6·5. G = 4·65...4·9. Emits a smell of sulphur when pounded.

FeS^2, iron 46·67, sulphur 53·33.

Its reactions are the same as those of pyrite. Decomposes readily.

Analyses of marcasite *a* by Berzelius, *b*, *c* by Hatchett, *d* from the Briccius mine near Annaberg (Breithaupt's kyrosite) by Scheidhauer:—

	a	*b*	*c*	*d*
Iron . .	45·07	45·66	46·40	45·60
Manganese	0·70	—	copper	1·41
Sulphur .	53·35	54·34	53·60	53·05
Silica . .	0·80	—	arsenic	0·93

Marcasite and pyrites having the same chemical composition, it follows that FeS^2 is dimorphous.

In crystals, globular, botryoidal, reniform, having a radiating columnar or fibrous structure; massive; pseudomorphous after calcite, fluor, pyrite, stephanite, proustite, disseminated; earthy.

Is not so abundant as pyrites, and is not found in the older rocks. It frequently accompanies pit coal and brown coal; occurs in sandstone, marl, chalk, beds of clay, and in peat. Is found in Saxony near Freiberg, Memmendorf in Bohemia; at Johann-Georgenstadt, Joachimsthal, Littmitz and Altsattel near Töplitz, Przibram; Almerode in Hessia; in the Harz at Clausthal, Zellerfeld, Iberg; Condé in France; Cornwall; Derbyshire.

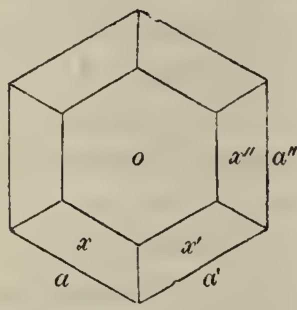
61. MOLYBDENITE.—Sulphuret of molybdena; Phillips. Molybdene; Hauy. Dirhomboedrischer Eutom-Glanz; Mohs. Molybdänglanz; Hausmann. Molybdänit; Haidinger.

Rhombohedral.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *x* 120.

ao	90°	0′
aa′	60	0
ba′	30	0

FIG. 169.



Combinations. *oa*, *ax*. The faces *o* smooth; *x*, *a* striated parallel to their intersections with *o*. Cleavage. *o*, very perfect. Opaque. Lustre metallic. Lead-grey. Streak the same on paper; on porcelain greenish-grey. In thin leaves very flexible. Very sectile. H = 1·0...1·5. G = 4·5...4·6.

Before the blowpipe in the forceps imparts a green colour to the flame; on charcoal sulphurous acid is disengaged, and a white sublimate is deposited upon the charcoal. In the inner flame imparts a brown colour to a mixture of borax and nitre. In powder is decomposed by nitric acid, leaving a residue of molybdic acid. With hot nitromuriatic acid forms a greenish solution; with boiling sulphuric acid a blue solution.

MoS^2, molybdenum 58·92, sulphur 41·08.

Analyses of molybdenite *a* from Altenberg by Brandes, *b* from Chester in Pennsylvania by Seybert, *c*, *d*, *e* from Lindas in Smaland, *f* from Bohuslän by Svanberg and Struve :—

	a	*b*	*c*	*d*	*e*	*f*
Molybdenum .	59·6	59·42	59·07	59·10	59·13	59·01
Sulphur	40·4	39·68	40·93	40·90	40·87	40·99

In crystals, massive, disseminated and investing other minerals.

Occurs imbedded in granite, syenite, gneiss and chlorite slate; sometimes in beds with magnetite, in veins of cassiterite. Is found with cassiterite at Altenberg and Ehrenfriedersdorf in Saxony, and Schlackenwald and Zinnwald in Bohemia; in granite in the iron mine at Bispberg near Säther, and near Stockholm in Sweden, with augite in beds of iron ore and in zircon syenite at Laurwig in Norway, Rathhausberg in Salzburg, Wallis, Silesia, Chessy in France, in granite at the foot of the Talèfre near Mont Blanc, abundantly in granite and gneiss in the United States, Peru, the Brazils, with tin and copper in the Drake-walls mine near Calstock, near Menabilly, Huel Unity and Huel Gorland in Cornwall, in the granite of Caldbeckfell near the source of the Caldew in Cumberland, Shap in Westmoreland, in chlorite slate at Glenelg in Inverness-shire, and in granite on the mountain of Coryby at the head of Loch Creran in Scotland.

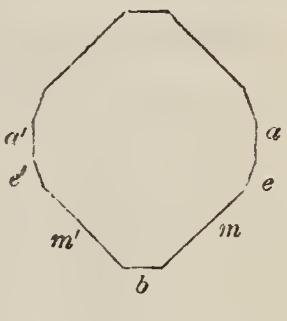
62. BISMUTHINE.—Sulphuret of Bismuth; Phillips. Bismuth sulphuré; Hauy. Prismatischer Wismuth-Glanz; Mohs. Wismuthglanz; Hausmann. Bismuthin; Haidinger.

Prismatic. 110,100 = 45° 30′.

a 100, *b* 010, *c* 001 cleavage, *m* 110, *e* 310.

bc	90°	0′
ca	90	0
ca	18	44
ma	45	30
ba	90	0
mm′	89	0

FIG. 170.



Combination. *mabe*. Crystals obtained by fusing sulphide of bismuth are combinations of *amb*. The faces *m* deeply striated parallel to their intersections with *a*. Cleavage. *a*, perfect; *b*, less perfect; *c*, *m*, imperfect. Fracture imperfect conchoidal, seldom observable. Opaque. Lustre metallic. Lead-grey, inclining to tin-white; acquires a yellowish or variegated tarnish. Streak the same. Sectile. H = 2·0. G = 6·4...6·5.

In the open tube yields a sublimate of sulphur, with disengagement of sulphurous acid, and boils. Before the blowpipe on charcoal, in the inner flame, melts readily with effervescence, yields a yellow sublimate, and a globule of bismuth. Partially soluble in nitric acid, leaving a residue of sulphur.

BiS^3, bismuth 81·60, sulphur 18·40.

Analyses of bismuthine *a* from Riddarhyttan by H. Rose, *b* from Retzbanya by Wehrle, *c* from Gjellebäk by Scheerer :—

	a	*b*	*c*
Bismuth . . .	80·98	80·96	79·77
Copper	—	—	0·14
Iron	—	—	0·15
Sulphur	18·72	18·28	19·12

In attached crystals, granular and columnar masses, and disseminated.

Occurs in beds and veins, especially in crystalline slate rocks and granite. Is found in beds at Riddrhytta in Westmanland with towanite, pyrite, cererite, amphibole, and many other parts of Sweden ; Altenberg, Schneeberg and some other places in Saxony ; in veins in quartz with bismuth, smaltine, towanite and mispickel, at Joachimsthal in Bohemia ; Drammen in Norway, the Beresow mountains in Siberia, near Redruth and the Land's End in Cornwall, Caldbeckfell in Cumberland.

63. ANTIMONITE. — Sulphuret of antimony ; Phillips. Antimoine sulfuré ; Hauy. Prismatoidischer Antimon-Glanz ; Mohs, Hausmann. Antimonit ; Haidinger.

Prismatic. 011,010=44° 1′; 101,001=45° 36′·5; 110,100=45° 22′·5.

a 100, *b* 010, *c* 001, *x* 102, *u* 101, *m* 110, *n* 120, *r* 430, *t* 510, *s* 113, *p* 111, *v* 211, *e* 213.

bc	90°	0′	*ec*	37°	21′
ua	44	24	*sa*	72	9
xa	62	56	*sb*	71	55
ca	90	0	*sc*	25	53
uu′	91	13	*pm*	34	31
xx′	54	8	*sm*	64	8
ta	11	27	*cm*	90	0
ra	37	14	*va*	35	10
ma	45	23	*pa*	54	38
na	63	44	*pp′*	70	44
ba	90	0	*pp″*	71	50
mm′	89	15	*p′p″*	110	58
ea	57	13	*vv″*	49	2
eb	74	3	*v′v″*	132	48

FIG. 171.

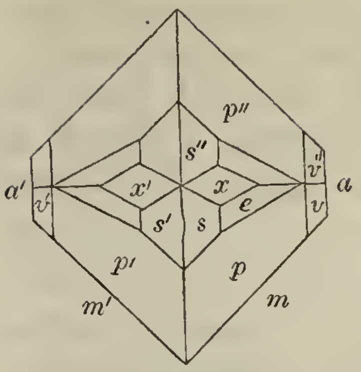
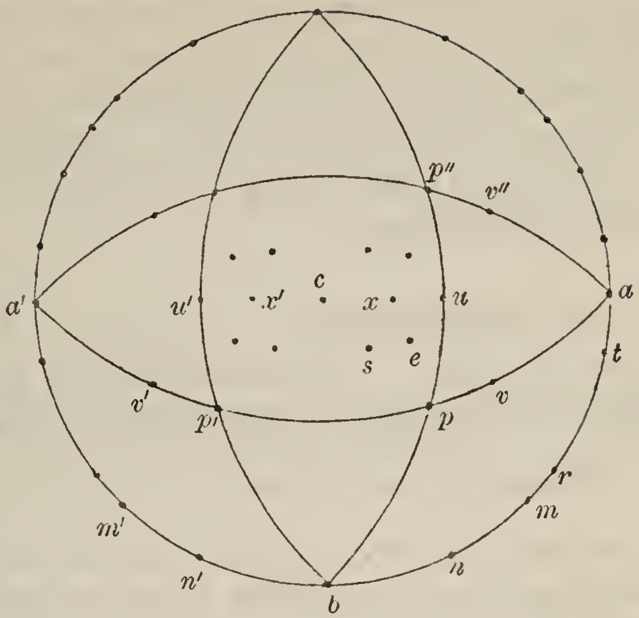


FIG 172.



Combinations. *sma, pma, pvma, svpma, sxepvma.* The faces of the zone *ma* striated parallel to their intersections with each other. Cleavage. *a*, very perfect; *c, m, b* less perfect. Fracture conchoidal, small and imperfect. Opaque. Lustre metallic. Lead-grey, inclining to steel-grey; acquires a steel-blue or iridescent tarnish. Streak lead-grey. Sectile. In thin leaves flexible. H = 2·0. G = 4·6...4·7.

In the open tube yields first a sublimate of antimonious acid, and then of oxide of antimony. Before the blowpipe on charcoal melts very readily, imparts a green colour to the flame, is volatilized, and deposits a white sublimate on the charcoal. Is soluble when pure in warm hydrochloric acid; usually leaves a small quantity of chloride of lead. Decomposed by nitric acid, leaving oxide of antimony. Decomposed by caustic potash, forming with it a yellow solution, which yields a yellowish red precipitate on the addition of an acid.

SbS^3, antimony 72·89, sulphur 27·11.

Analyses *a* by Bergman, *b* by Thomson, *c* by J. Davy, *d* by Brandes, *e* from Arnsberg in Westphalia by Schnabel :—

	a	*b*	*c*	*d*	*e*
Antimony . . .	74	73·77	74·06	73·5	72·02
Iron	—	—	—	—	0·13
Sulphur . . .	26	26·23	25·94	26·5	27·85

In long columnar or acicular crystals, radiating columnar, fibrous and granular masses, and disseminated.

Occurs usually in veins in granite and slate rocks, either alone or with gold, silver and ores of lead and other metals, sometimes in beds in chalybite. Is found near Pösing not far from Presburg, Felsöbanya, Kremnitz, Schemnitz, Magurka and other places in Hungary, Kapnik in Transylvania, Bräunsdorf near Freiberg in Saxony, Michelsberg and Przibram in

Bohemia, Neudorf, Wolfsthal and Andreasberg in the Harz, Arensberg in Westphalia, Auvergne and other places in France, Wolfach in Baden, Leogang near Salzburg, Schladming in Styria, Lavantthal in Carinthia, Gold Kronach in Baireuth, Schlangenberg in Siberia, Loretto in Tuscany, Padstow in Cornwall, Glendinning in Dumfriesshire, Spain, North and South America.

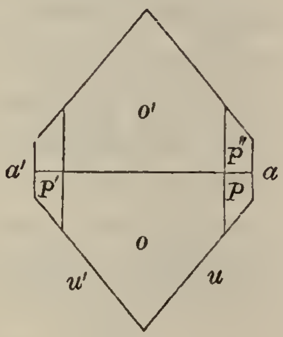
64. ORPIMENT.—Orpiment; Phillips. Arsenic sulfuré jaune; Hauy. Prismatoidischer Schwefel; Mohs. Rauschgelb; Hausmann. Operment; Haidinger.

Prismatic. 011,010=41° 45′; 101,001=33° 0′; 110,100=59° 54′·5.

a 100, *b* 010, *o* 011, *m* 110, *u* 210, *p* 111, *v* 211. *b* truncates the edge *uu′*, *m* truncates the edge *ub*, *v* truncates the edge *pa*.

ob	41°	45′	*mm′*	62°	11′
oo′	96	30	*va*	48	3
ua	39	40	*pa*	65	48
ma	58	55	*oa*	90	0
ba	90	0	*pb*	47	10
uu′	100	40	*pm*	37	27

FIG. 173.



Combinations. *pmu*, *opmu*, *opua*, *opvmub*, *abomu*. The faces *a* rough but even; *m*, *u* striated parallel to their intersections with *a*. Cleavage. *a*, very perfect; *b*, traces. Semi-transparent …translucent on the edges. Lustre resinous; on the cleavage *a* pearly, inclining to metallic. Lemon-yellow, inclining to orange-yellow. Sectile. In thin leaves flexible. H = 1·5. G = 3·48.

In the matrass yields a dark yellow or red sublimate. In the open tube burns, yields sulphurous acid, and deposits a sublimate of arsenious acid. Fused with soda yields metallic arsenic. Soluble in nitromuriatic acid, caustic potash and ammonia.

AsS^3, arsenic 60·95, sulphur 39·05.

Analyses of orpiment by Klaproth and Laugier:—

Arsenic	62	61·86
Sulphur	38	38·14

In imbedded crystals; botryoidal, reniform, stalactitic, massive and disseminated. In beds of clay, less frequently in veins with realgar. In veins with arsenic, bismuth, blende, pyrargyrite at Kapnik, Nagyag, Felsöbanya, Joachimsthal, Schneeberg, Andreasberg, Wittichen and Markirchen; in beds of clay at Tajowa near Neusohl, in dolomite on St. Gotthardt, in limestone and gypsum at Falkenstein and Hall in the Tyrol; as a volcanic sublimate in the Solfatara, on the lava of Vesuvius, Guadaloupe, Kiusiu in Japan.

65. REALGAR.—Realgar; Phillips. Arsenic sulfuré rouge; Hauy. Hemiprismatischer Schwefel; Mohs. Realgar; Hausmann, Haidinger.

Oblique. 101,100=73° 32′·5; 111,010=46° 59′; 101,001=40° 22′·5.

a 100, *b* 010, *c* 001, *x* 101, *z* 201, *r* 012, *q* 011, *y* 032, *v* 230, *m* 110, *w* 430, *l* 210, *g* 520, *n* 212, *e* 111, *k* 232, *d* 412, *t* 612, *u* 421, *f* $\bar{2}12$.

za	44°	2′	*nb*	64°	59′	*fb*	72°	33′
xa	73	33	*xb*	90	0	*cm*	75	48
ca	113	55	*db*	71	19	*xm*	80	8
yb	36	51	*zb*	90	0	*fba′*	40	13
qb	48	21	*tb*	76	34	*tba*	29	25
rb	66	2	*ub*	54	15	*uba*	21	42
cb	90	0						
vb	26	51						
mb	37	13						
wb	45	20						
lb	56	38						
gb	62	14						
kb	35	33						
eb	46	59						

FIG. 174.

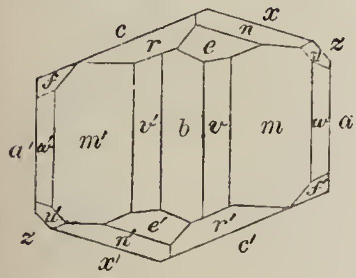
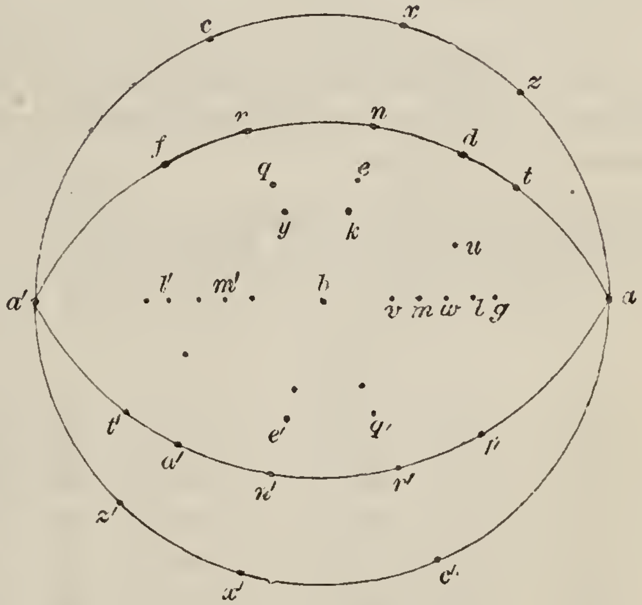


FIG. 175.



Combinations. *cm*, *cmrl*, *xrml*, *crmle*, *crmleb*, *crmltzab*, *nrceqfmwlvab*, *xnezucrfmwvab*. The faces *s*, *g*, *e*, *w*, *m*, *v*, *b* striated parallel to their intersections with each other. Cleavage. *c*, *b*, tolerably perfect; *n*, *m*, *a*, less distinct. *l*, traces. Fracture conchoidal. Semi-transparent...translucent. Lustre resinous. R = 2·549. Aurora red. Streak orange-yellow. Sectile. H = 1·5. G = 3·556.

In the matrass sublimes. The sublimate is dark yellow, and transparent, sometimes red. In the open tube burns, depositing a sublimate of arsenious acid. Before the blowpipe on charcoal melts and burns with a yellowish-white flame. Soluble with difficulty in acids. In hot nitromuriatic acid dissolves slowly, leaving a residue of sulphur. In warm caustic potash is changed into a dark powder.

AsS^2, arsenic 70·07, sulphur 29·93.

Analyses by Klaproth and Laugier:—

Arsenic	68·0	69·57
Sulphur	30·5	30·43

In attached crystals and druses, massive, disseminated and investing other minerals.

Is found in veins with arsenic, antimonite, pyrargyrite, blende, galena, pyrite, mispickel, &c., in veins at Kapnik and Nagyag in Transylvania, Felsöbanya in Hungary, Joachimsthal in Bohemia, Schneeberg in Saxony, Andreasberg and Wolfsberg in the Harz, Markirchen in Alsace, Wittichen in Baden; in beds of clay at Tajowa in Hungary; in beds of dolomite on St. Gotthardt; in limestone at Kranabit; in gypsum at Hall in the Tyrol; in Peru; in the United States; as a product of sublimation in Vesuvius and Ætna, Kiusiu in Japan.

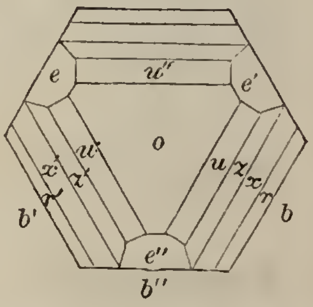
66. CINNABAR.—Cinnabar; Phillips. Mercure sulfuré; Hauy. Peritome Rubin-Blende; Mohs. Zinnober; Hausmann, Haidinger.

Rhombohedral. 100,111 = 69° 17′.

o 111, *b* $2\bar{1}\bar{1}$, *e* 011, *r* 100, *u* 211, *x* 311, *z* 522.

bb″	60°	0′	*uu′*	57°	4′
uo	33	28	*ee′*	87	24
zo	41	24	*ue′*	43	42
xo	46	36	*zz′*	69	54
ro	69	17	*xx′*	78	2
bo	90	0	*rr′*	108	12
eo	52	54	*er′*	54	6

FIG. 176.



Combinations. *ob*, *ouzr*, *ozrb*, *ouzxerb*. The faces *u*, *z*, *x*, *e* are striated parallel to their intersections with *o*. Twins. Twin-face *o*. Cleavage. *b*, very perfect. Semi-transparent…translucent on the edges. Lustre adamantine. Cochineal-red, passing into lead-grey and scarlet-red. Streak scarlet-red. Sectile. H = 2·5. G = 8·0…8·2. Conducts electricity imperfectly.

In the matrass sublimes unchanged. In the open tube yields a sublimate of undecomposed cinnabar and metallic mercury with a disengagement of sulphurous acid. In the matrass with soda yields a sublimate of mercury. Soluble in nitromuriatic acid, leaving a residuum of sulphur. Insoluble in hydrochloric and nitric acids, and in caustic potash.

HgS, mercury 86·21, sulphur 13·79.

Analyses of cinnabar *a* from Japan, *b* from Carinthia by Klaproth, *c* from Silberg near Olpe in Westphalia, *d* from Hohensolms near Wetzlar by Schnabel:—

	a	*b*	*c*	*d*
Mercury . . .	84·50	85·00	86·79	85·43
Sulphur . . .	14·75	14·25	13·67	13·92

In attached crystals, single or in druses, granular and earthy masses, disseminated and investing other minerals.

Cinnabar occurs usually in beds with mercury, amalgam, less frequently in veins with pyrite, quartz, calcite, &c. Is found at Almaden, Almadenejos and in the Asturias in Spain, Idria and Neumarktel in Carniola; Wolfstein, the Stahlberg, Moschel-Landsberg, the Potzberg near Kusel, in the Palatinate, in many parts of Carinthia, Eisenerz in Stiria, Horzowitz in Bohemia; Schemnitz, Kremnitz, Szlana and Rosenau in Hungary; Hartenstein in Saxony, Clausthal in the Harz, Dumbrawa in Transylvania, the Ural, and in large quantities in Mexico, Peru, China and Japan.

The massive variety from Idria, called lebererz or hepatic cinnabar, of a dark red or black colour (G = 6·287) according to Schrötter, consists of:—

Cinnabar	90·40
Idrialine	4·21
Sulphide of iron . . .	0·42
Sulphate of lime . . .	0·03
Sulphur	0·54
Silica	2·73
Alumina	0·76

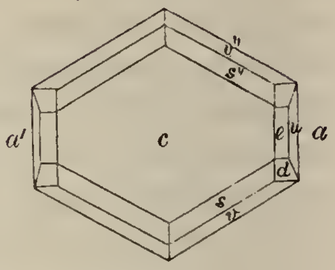
67. STERNBERGITE.—Sternbergite; Dufrénoy. Flexible silver; Bournon. Prismatischer Eutom-Glanz; Mohs. Sternbergit; Hausmann, Haidinger.

Prismatic. 011,010 = 34° 48′; 101,001 = 40° 0′; 110,100 = 59° 45′.

a 100, *c* 001, *e* 201, *u* 10 0 1, *w* 061, *v* 221, *s* 111, *d* 211, *m* 110 twin plane.

ec	59°	12′	*ma*	59°	45′
uc	83	12	*sa*	64	24
ac	90	0	*ss″*	95	32
wc	76	31	*va*	61	8
wa	90	0	*vv″*	111	38
sc	59	0	*da*	46	14
vc	73	17	*dd″*	72	43
mc	90	0	*dc*	65	38

FIG. 177.



Combinations. *cdvua*, *cuseu*, *cwedva*, *csedvu*. Twins. Twin-face *m*. The face *c* striated parallel to its intersections with *w*, the other faces striated parallel to their intersections with *c*. Cleavage. *c*, very perfect, and easily obtained. Lustre metallic, brightest on *c*. Pinchbeck brown. Streak black. Very sectile. In thin leaves flexible. H = 1·0...1·5. G = 4·215.

Before the blowpipe on charcoal burns with a blue flame, and smells of burning sulphur; fuses into a magnetic globule covered with silver. With borax yields a globule of silver and glass coloured by iron. Is decomposed by nitromuriatic acid, leaving sulphur and chloride of silver.

$\overset{\prime}{\mathrm{Ag}}\overset{\prime\prime\prime}{\cancel{\mathrm{F}}\mathrm{e}}^{2}$, silver 32·52, iron 33·74, sulphur 33·74.

Analysis of sternbergite from Joachimsthal by Zippe:—

Silver	33·2
Iron	36·0
Sulphur	30·0

In attached crystals, in fan-shaped and globular aggregations, and columnar masses. Is found in veins with pyrargyrite and argentite at Joachimsthal in Bohemia; Schneeberg and Johann-Georgenstadt in Saxony.

The flexible silver of Phillips is, as the angles demonstrate, a distorted figure of argentite. It was purchased by Mr. Brooke at a public sale as Bournon's mineral, and handed over as such to Mr. Phillips, and measured and described without reference to Bournon's Catalogue. The specimen of sternbergite now in Mr. Brooke's collection is in very perfect crystals, and was formerly in the possession of Count Bournon.

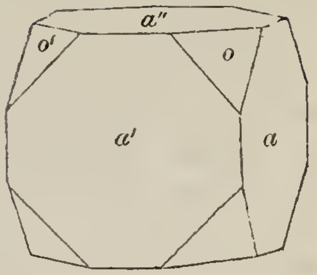
68. BORNITE.—Purple copper; Phillips. Cuivre pyriteux hepatique; Hauy. Oktaedrischer Kupfer-Kies; Mohs. Buntkupfererz; Hausmann. Bornit; Haidinger.

Cubic.

a 100, *o* 111, *d* 011.

aa′	90°	0′
oo′	70	32
oa	54	44
dd′	60	0
da	45	0

FIG. 178.



Forms and combination. *a*, *d*, *ao*. The faces *a* rough, sometimes curved. Twins. Twin-face *o*. Cleavage. *o*, traces. Fracture small conchoidal...uneven. Opaque. Lustre metallic. Between copper-red and pinchbeck-brown. Acquires an iridescent tarnish when exposed to a moist atmosphere. Streak greyish-black. Rather sectile. H = 3·0. G = 4·9...5·1.

In the open tube yields sulphurous acid, but no sublimate. Before the blowpipe on charcoal turns black, and after cooling, red. After long exposure to the flame, fuses into a steel-grey, brittle, magnetic globule. Fused with borax and soda yields a globule of copper. After roasting shows with fluxes the reactions of oxides of copper and iron. Moistened with hydrochloric acid colours the flame blue. Concentrated hydrochloric acid dissolves it partially, leaving the greater part of the sulphur.

$\overset{\prime}{\cancel{C}}u^{3}\overset{\prime\prime\prime}{\cancel{F}}e$, copper 55·57, iron 16·37, sulphur 28·06.

The massive varieties probably contain a mechanical mixture of redruthite or towanite.

Analysis of crystallized bornite *a* from Condurra mine by Plattner, *b* crystallized from Redruth by Chodnew, *c* crystallized by Varrentrapp, *d* from Ross Island Killarney by R. Phillips, *e* massive from Sangerhausen, *f* massive from Eisleben, *g* massive from the Woitzkoi mine near the White Sea, *h* massive from Martanberg in Dalarne, all by Plattner, *i* from Vestanforss in Sweden by Hisinger, *k*, *l* massive from Bristol in Connecticut by Bodemann:—

	a	*b*	*c*	*d*	*e*	*f*
Copper .	56·76	57·89	58·20	61·07	71·00	69·73
Iron . .	14·84	14·94	14·85	14·00	6·41	7·54
Sulphur .	28·24	26·84	26·98	23·75	22·58	22·65
Quartz .	—	0·04	—	0·50	—	—

	g	*h*	*i*	*k*	*l*
Copper .	63·03	56·10	63·33	62·75	62·65
Iron . .	11·57	17·36	11·80	11·64	11·42
Sulphur .	25·06	25·80	24·70	25·70	undetermined
Quartz .	—	0·12	—	0·04	0·02

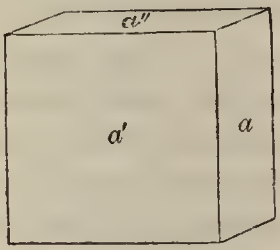
Very seldom crystallized; usually massive and disseminated.

Occurs in beds and veins in the older rocks with towanite, redruthite, pyrite, malachite, quartz, chalybite, baryte, calcite, fluor, &c. Is found at Orawitza in the Banat, and Arendal in Norway in beds with garnets, in beds in bituminous marl slate at Saalfeld and Kamsdorf in Thuringia, in Siegen in veins in iron stone, Leogang in Salzburg, Rudelstadt and Kupferberg in Silesia, Hessia, Siberia, Greenland, Sweden, North America, in veins in gneiss at Annaberg and Freiberg in Saxony, Rammelsberg in the Harz, crystallized only in veins near Redruth and St. Day in Cornwall.

69. CUBANE.—Cuban; Hausmann, Haidinger.

Cubic.

FIG. 179.



a 100 cleavage.

aa' 90° 0′

Cleavage. *a*, distinct. Opaque. Lustre metallic. Between brass-yellow and bronze-yellow. Streak black. H = 4·0. G = 4·026 ...4·042.

Easily fusible before the blowpipe. Its reactions in other respects are the same as those of towanite.

$\overset{\prime}{\cancel{\mathrm{Cu}}}\overset{\prime\prime\prime}{\cancel{\mathrm{Fe}}} + 2\overset{\prime}{\mathrm{Fe}}$, copper 23·35, iron 41·27, sulphur 35·38.

Analysis by Scheidhauer:—

Copper	22·96
Iron	42·51
Lead	a trace
Sulphur	34·78

Is found at Bacaranao in Cuba.

70. TOWANITE.—Copper pyrites; Phillips. Cuivre pyriteux; Hauy. Pyramidaler Kupfer-Kies; Mohs. Kupferkies; Hausmann. Chalkopyrit; Haidinger.

Pyramidal. 101,001 = 44° 34′·5.

a 100, *c* 001, *m* 110, *w* 310, *g* 203, *e* 101, *h* 302, *z* 201, *d* 114, *x* 113, *p* 111, *n* 112, *r* 332, *t* 221, *v* 316, *k* 511. *d*, *e*, *p*, *n*, *v*, *k* are usually hemihedral with inclined faces.

wa	18°	26′
ma	45	0
aa′	90	0
gc	33	18
ec	44	35
hc	55	55
zc	63	6
ac	90	0
dc	19	13
xc	24	55
nc	34	52
pc	54	20
rc	64	26
tc	70	16
mc	90	0
vc	27	27
ka	15	53
pa	54	57
ae′	90	0
dd′	24	54
xx′	34	40
vx	11	54
gx	22	51
gg′	45	41
nn′	47	41
ee′	59	30
en	29	45
pe	35	40
pp′	70	7
hh′	71	42
pz	39	6
zz′	78	10
rr′	79	16
tt′	83	27

FIG. 180.

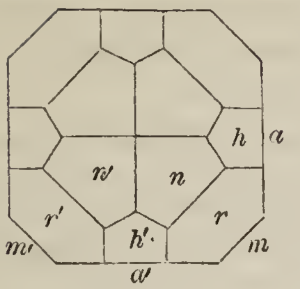


FIG. 181.

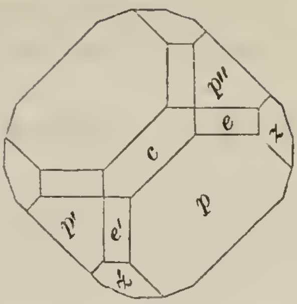


FIG. 182.

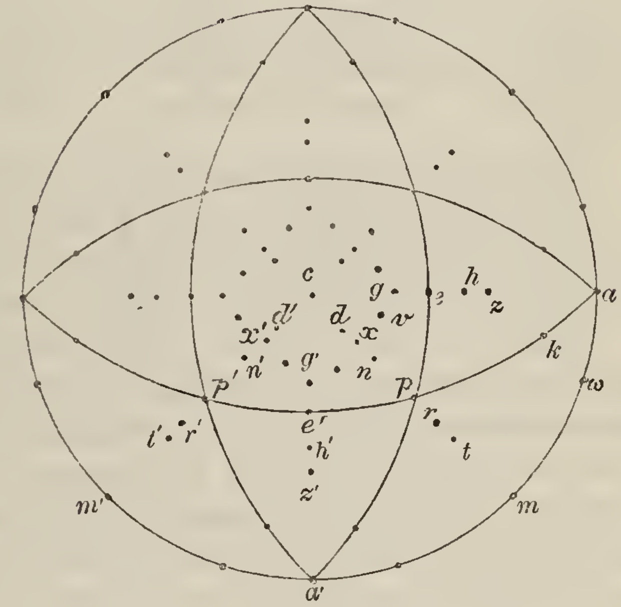


FIG. 183.

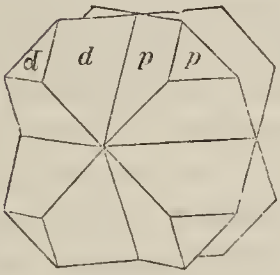
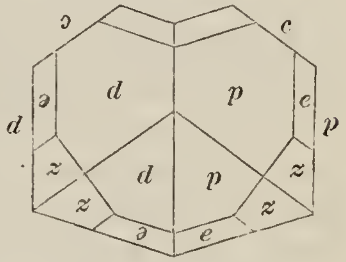


FIG. 184.



Combinations. *p′p‵*, *cp′p‵*, *p′p‵z*, *p′p‵a*, *cp′p‵z*, *cep′p‵z*, *cp′p‵zm*, *amhnrcep′p‵zw*, *cn‵ep′p‵zaw*, *cd‵x‵v‵gp′p‵ehz*. The faces *e* are striated parallel to their intersections with *c*; the faces *p* are striated parallel to their intersections with *z*. Twins. 1. Twin-face *a*. 2. Twin-face *p*. 3. Twin-face *e*. Cleavage. *z*, perfect, but interrupted; *c*, indistinct. Fracture conchoidal, more or less perfect. Opaque. Lustre metallic. Brass-yellow. Streak greenish-black. Slightly brittle. H = 3·5...4·0. G = 4·1...4·3.

Before the blowpipe on charcoal melts easily and quietly into a brittle, grey, magnetic globule. Colours glass of borax green.

After long-continued roasting in the outer flame yields a bead of copper when fused with a small quantity of borax. Partially soluble in concentrated nitric acid; more readily in nitromuriatic acid, leaving a residue of sulphur.

$\overset{\prime}{\bar{\mathrm{Cu}}}\overset{\prime\prime\prime}{\bar{\mathrm{Fe}}}$, copper 34·55, iron 30·54, sulphur 34·91.

Analyses of crystallized towanite *a* from Ramberg, *b* from Kinzigthal, both by H. Rose, *c* crystallized from Cornwall by R. Phillips, *d* massive from Orijerfvi in Finland by Hartwall, *e* massive from Saxony, *f* massive, both by Berthier :—

	a	*b*	*c*	*d*	*e*	*f*
Copper . .	34·49	33·25	30·15	32·93	34·2	31·7
Iron . . .	30·55	30·12	32·37	30·71	30·8	32·7
Sulphur .	35·97	36·66	35·34	37·15	32·9	34·2

It sometimes contains traces of silver or gold.

In crystals, usually twins, either attached singly or united in druses; more frequently massive and disseminated; sometimes botryoidal and reniform; pseudomorphous after redruthite.

Occurs in beds with pyrite, blende, galena, mispickel, cobaltine, in veins with quartz, calcite, baryte, fluor, chalybite, and in small quantities in veins containing ores of silver, lead, tin, &c. Is found near Freyberg in Saxony, Schlackenwald and Ratieborzitz in Bohemia, in many parts of Stiria, Kamsdorf, Mansfeld, Lauterberg and Goslar, Müsen, Eiserfeld, Dillenburg, Schapbach and Wolfach in Baden, Auerbach on the Bergstrasse, Röraas in Norway, Fahlun, Garpenberg, Nya Kopparberg in Sweden; very abundantly in Cornwall in veins in granite and clay slate; in Anglesea in a bed of great thickness with native copper, sparingly in Derbyshire, Staffordshire and Cumberland, in the Clifton mine near Tyndrum in Perthshire, in Mainland, one of the Shetland isles, in the mines of Cronebawn and Ballymurtagh in Wicklow in Ireland, in Hungary, the Banat, Siberia, North and South America, Africa, Japan. The best crystals are found in Cornwall, near Freiberg, and in the Pfaffenberg and Meiseberg in Anhalt.

71. PATRINITE.—Plumbo-cupriferous sulphuret of bismuth; Phillips. Bismuth sulfuré plombo-cuprifère; Dufrénoy. Prismatoidischer Wismuth-Glanz; Mohs. Nadelerz; Hausmann. Patrinit; Haidinger.

Prismatic. Probably isomorphous with bournonite.

Has a single cleavage parallel to the axis of the prism. Fracture imperfect conchoidal...uneven. Opaque. Lustre metallic. Blackish lead-grey...steel-grey. Acquires a brown tarnish by exposure. Streak blackish-grey. Slightly brittle. H = 2·0...2·5. G = 6·75.

In the open tube yields sulphurous acid, and a white vapour, part of which condenses in transparent drops. Before the blowpipe on charcoal melts very easily, emits fumes, and deposits a white and yellow sublimate upon the charcoal, and leaves a metallic bead which, with soda, yields a globule of copper. Partially soluble in nitric acid, leaving sulphate of lead and sulphur.

$\overset{\prime}{\cancel{\mathrm{C}}\mathrm{u}}{}^3\overset{\prime\prime\prime}{\mathrm{Bi}} + 2\overset{\prime}{\mathrm{Pb}}{}^3\overset{\prime\prime\prime}{\mathrm{Bi}}$, copper 10·94, lead 35·75, bismuth 36·74, sulphur 16·57.

Analyses *a*, *b* by Frick, *c*, *d* from Katharinenburg by Chapman:—

	a	*b*	*c*	*d*
Copper . . .	11·79	10·59	12·64	10·94
Lead	35·69	36·05	40·43	35·77
Bismuth . . .	34·62	36·45	28·04	36·73
Sulphur . . .	16·05	16·61	18·89	16·56

In long slender four and six-sided prisms, striated parallel to the intersections of the faces, imbedded in quartz, massive and disseminated.

Is found associated with gold in the Pyschminski, Preobraschenski and Kljutschewski mines at Beresow near Katharinenburg in Siberia.

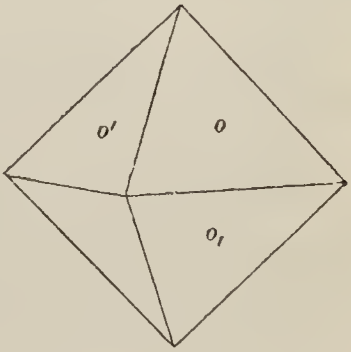
72. GRÜNAUITE.—Grünauite; Nicol. Nickel sulfuré bismuthifère; Dufrénoy. Nickelwismuthglanz; Mohs, Hausmann, Haidinger.

Cubic.

a 100, *o* 111.

aa′	90°	0′
oo′	70	32
oa	54	44

FIG. 185.



Form and combination. *o*, *ao*. Cleavage. *o*. Opaque. Lustre metallic. Light steel-grey, silver-white. Acquires a yellowish and greyish tarnish. Streak dark grey. Brittle. H = 4·5. G = 5·13.

Before the blowpipe melts into a grey, brittle, magnetic bead, depositing a greenish-yellow sublimate on the charcoal. Dissolves in nitric acid, leaving a residue of sulphur. The solution is green; when neutral, it yields a precipitate on the addition of water.

Analyses *a* by v. Kobell, *b*, *c* by Schnabel:—

	a	*b*	*c*
Nickel . . .	40·65	22·03	22·78
Iron	3·48	5·55	6·06
Cobalt . . .	0·28	11·24	11·73
Bismuth . .	14·11	10·49	10·41
Copper . . .	1·68	11·59	11·56
Lead	1·58	7·11	4·36
Sulphur . . .	38·64	31·99	33·10

Is found in very small crystals and granular aggregations at Grünau in Sayn Altenkirchen with quartz and towanite.

73. LINNÉITE.—Sulphuret of cobalt; Phillips. Kobaldine; Beudant. Isometrischer Kobalt-Kies; Mohs. Kobaltkies; Hausmann. Linnéit; Haidinger.

Cubic.

a 100, *o* 111.

aa′	90°	0′	
oo′	70	32	(fig. 190.)
oa	54	44	

Form and combination. *o*, *ao*. Twins. Twin-face *o*. Cleavage. *a*, imperfect. Fracture conchoidal...uneven. Surface smooth. Opaque. Lustre metallic. Silver-white, inclining to steel-grey. Acquires a yellowish or copper-red tarnish. Streak blackish-grey. Brittle. H = 5·5. G = 4·8...5·0.

Before the blowpipe yields sulphurous acid, and melts in the inner flame into a grey magnetic globule, the interior of which is bronze-yellow. Imparts a blue colour to glass of borax. Partially soluble in warm nitric acid, leaving a residue of sulphur.

$\overset{\prime}{\mathrm{C}}\mathrm{o}\overset{\prime\prime\prime}{\cancel{\mathrm{C}}}\mathrm{o}$, cobalt 58·01, sulphur 41·99, a large portion of the cobalt being replaced by copper, nickel, and iron.

Analyses of Linnéite *a*, *b* from the Jungfer mine near Müsen by Wernekink, *c* from Riddarhytta, with an admixture of towanite, by Hisinger, *d* from the Jungfer mine near Müsen by Schnabel, *e* from the Schwaben mine near Müsen by Ebbinghaus:

	a	*b*	*c*	*d*	*e*
Cobalt . . .	44·17	53·35	43·34	22·09	11·00
Nickel . . .	—	—	—	33·64	42·64

	a	*b*	*c*	*d*	*e*
Iron . . .	5·35	2·30	3·54	2·29	4·69
Copper . .	4·13	0·97	14·45	—	—
Sulphur . .	41·29	42·52	38·63	41·98	42·30

In crystals, massive and disseminated.

Is found crystallized with quartz, towanite, and pyrite in veins, in the Schwaben mine and the Stahlberg near Müsen in Siegen, massive and disseminated with towanite and amphibole in a bed in gneiss in the Nya Bastnäs mine at Riddarhytta, also at Loos in Sweden.

74. SYEPOORITE.—Syepoorite; Nicol. Graukobalterz; Hausmann.

Steel-grey, inclining to yellow.

CoS, cobalt 64·86, sulphur 35·14.

Analysis by Middleton:—

Cobalt	64·64
Sulphur	35·36

Occurs massive and disseminated at Syepoor near Rajpootanah in the west of Hindostan.

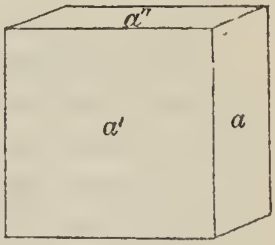
75. STANNINE.—Sulphuret of tin; Phillips. Etain sulfuré; Hauy. Hexaedrischer Dystom-Glanz; Mohs. Zinnkies; Hausmann. Stannin; Haidinger.

Cubic.

a 100, *d* 011 cleavage.

aa′	90° 0′
dd′	60 0
da	45 0

FIG. 186.



Cleavage, *a*, *d*, traces. Fracture uneven ... small conchoidal. Opaque. Lustre metallic. Steel-grey, inclining to bronze-yellow. The yellow colour of some varieties is occasioned by an admixture of towanite. Streak black. Brittle. H = 4·0. G = 4·3...4·51.

In the open tube yields white fumes and sulphurous acid. Before the blowpipe on charcoal, in a strong heat, melts, becomes white on the surface, and deposits a white sublimate of tin, which cannot be volatilized, close round the assay. After roasting yields with fluxes the reactions of copper and iron.

With soda and borax yields a pale scarcely malleable bead of copper. Is easily decomposed by nitric acid, forming a blue solution, and leaving sulphur and oxide of tin undissolved.

$\overset{\prime}{\mathrm{Ȼu}}{}^2\overset{\prime\prime}{\mathrm{Sn}} + \overset{\prime}{\mathrm{Fe}}{}^2\overset{\prime\prime}{\mathrm{Sn}}$, copper 29·58, iron 13·07, tin 27·47, sulphur 29·88, a portion of the iron being sometimes replaced by zinc.

Analyses of stanine from Huel Rock *a* by Klaproth, *b* by Kudernatsch, *c* from Zinnwald by Rammelsberg, *d* from St. Michael's Mount by Johnston:—

	a	*b*	*c*	*d*
Copper . . .	30·0	29·69	26·31	23·55
Iron	12·0	12·57	6·80	4·79
Zinc	—	1·79	6·93	10·11
Tin	26·5	25·81	28·94	31·62
Lead	—	—	0·41	—
Sulphur . . .	30·5	29·95	29·89	29·93

Is found at Zinnwald in Bohemia, and Huel Rock mines in St. Agnes, in a vein accompanied by blende and pyrite. It is said to have been found in Stenna Gwynn, in Huel Scorrier, and in small veins in the granite of St. Michael's Mount.

76. MISPICKEL.—Arsenical Iron; Phillips. Fer arsenical; Hauy. Prismatischer Arsenik-Kies; Mohs. Mispickel; Hausmann, Haidinger.

Prismatic. 011,010=29° 41′; 101,001=49° 56′; 110,100=55°56′·5.

a 100, *c* 001 cleavage, *e* 011, *l* 101, *s* 102, *r* 104, *t* 301, *m* 110, *g* 111, *x* 132. *c* truncates the edge *rr′*. *t* truncates the edge *la*. *g* is common to the zones *mc*, *ea*. *x* truncates the edge *em*.

ta	15° 28′	*rr′*	33° 32′
la	39 41	*em*	44 9
sa	58 56	*ee′*	120 48
ra	73 14	*ma*	55 36
ca	90 0	*mm′*	68 48
ll′	100 38	*gm*	25 7
ss′	62 8	*xm*	29 14

FIG. 187.

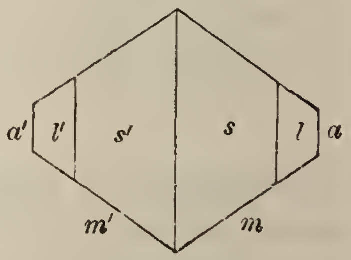
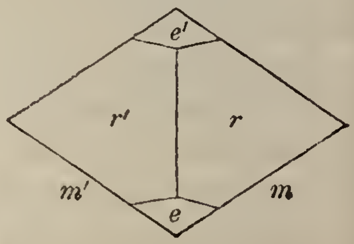


FIG. 188.



Combinations. *rm*, *rem*, *sem*, *lma*, *slma*. The faces *r* deeply striated parallel to the edge *rr′*; *s* rough, and striated parallel to the edge *ss′*; the other faces smooth. Twins. 1. Twin-face *c*. 2. Twin-face *m*. Cleavage. *m*, tolerably perfect; *c*, very faint traces. Fracture uneven. Opaque. Lustre metallic. Silver-white…light steel-grey. Streak greyish-black. Brittle. H = 5·5. G = 6·0…6·3.

In the matrass yields first a red and then a brown sublimate of sulphuret of arsenic; afterwards, in a strong heat, metallic arsenic sublimes. Before the blowpipe on charcoal emits arsenical fumes, and melts into a black magnetic globule. After being roasted, colours glass of borax green, the variety containing cobalt colours glass of borax or salt of phosphorus blue. Readily soluble in nitric acid, leaving a residue of sulphur and arsenious acid.

$FeS^2 + FeAs$, iron 34·37, sulphur 19·64, arsenic 45·99. In some varieties (danaite) part of the iron is replaced by cobalt; others contain a very small quantity of silver or gold.

Analyses of mispickel from Freyberg *a* by Stromeyer, *b* by Chevreuil, *c* by Karsten, *d* Breithaupt's 'plinian,' by Plattner:—

	a	*b*	*c*	*d*
Iron . . .	36·04	34·94	35·62	34·46
Sulphur . .	21·08	20·13	20·65	20·07
Arsenic . .	42·88	43·42	43·73	45·46

Analyses of the varieties containing cobalt (danaite) *e*, *f*, *g* from Skutterud by Scheerer, *h* by Wöhler, *i* from Franconia by Hayes:—

	e	*f*	*g*	*h*	*i*
Iron . . .	26·54	26·36	26·97	30·90	33·28
Cobalt . . .	8·31	9·01	8·38	4·70	6·52
Sulphur . .	17·57	17·34	18·06	17·70	18·02
Arsenic . .	47·55	46·76	46·01	47·40	41·86

In imbedded and attached crystals, frequently united in druses, granular and columnar masses, and disseminated.

Occurs in veins and beds, or disseminated in gneiss, mica slate, and serpentine, with cassiterite, wolfram, marcasite, fluor. Is found at Breitenbrunn, Raschau, Freiberg, Bräunsdorf, Munzig, the tin mines of Altenberg, Geger and Ehrenfriedersdorf in Saxony, in the tin mines of Joachimsthal, Schlackenwald and Zinnwald in Bohemia, Kupferberg and Altenberg in Silesia, Gölnitz in Hungary, Orawitza in the Banat, near Salathna in Transylvania, Lungau in Salzburg, Andreasberg, the Rammelsberg mine near Goslar, Sala, Mora and Norrberke in Sweden, in most of the tin mines in Cornwall. Danaite is found in beds with cobaltine at Skutterud in Norway and Franconia in the United States.

Mr. Greg's collection contains some crystals enclosing towanite, called by Haidinger 'prismatic cobalt pyrites,' having the form of mispickel, and in which, according to Haidinger's measurements, $mm' = 69° 0'$, $ll' = 99° 30'$. These are probably either danaite or glaucodote.

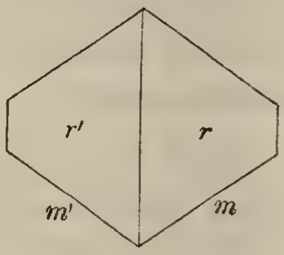
77. GLAUCODOTE.—Glaucodote; Breithaupt.

Prismatic.

c truncates the edge rr'.

mc	90°	0′
mm'	67	24

FIG. 189.



Cleavage. c, very distinct; m, indistinct. Opaque. Lustre metallic. Dark tin-white. Streak black. H = 5·0. G = 5·975...6·003.

$RS^2 + RAs$, where R is Co and Fe.

In the open tube yields sulphurous acid and a sublimate of arsenious acid. Before the blowpipe on charcoal emits fumes of sulphur and arsenic, and melts into a feebly magnetic globule with a black, rough surface. With borax in the inner flame yields the reaction of iron. When all the iron is separated by borax, the remaining arsenide melted with borax yields a blue glass.

$RS^2 + RAs$, where R is Co and Fe.

Analysis by Plattner:—

Cobalt, with a trace of nickel . . .	24·77
Iron	11·90
Arsenic	43·20
Sulphur	20·21

Is found in veins in chlorite slate, with cobaltine, towanite, axinite, and quartz, near Huasko in Chile.

78. COBALTINE.—Bright white cobalt; Phillips. Cobalt gris; Hauy. Hexaedrischer Kobalt-Kies; Mohs. Kobalt glanz; Hausmann. Kobaltin; Haidinger.

Cubic.

a 100, o 111, e 120, h 140, s 231. The forms e, h, s are hemihedral with parallel faces.

aa	90°	0′	ea'	26°	34′	ee'	53°	8′
oo'	70	32	ha'	14	2	eo	39	44
oa	54	44	so	22	13	se	17	31

FIG. 190.

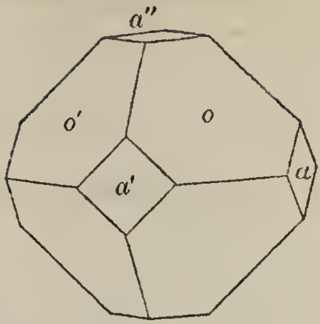


FIG. 191.

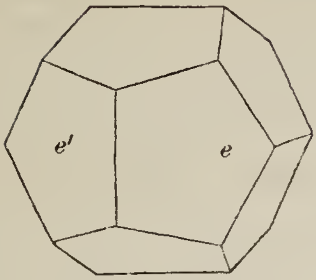
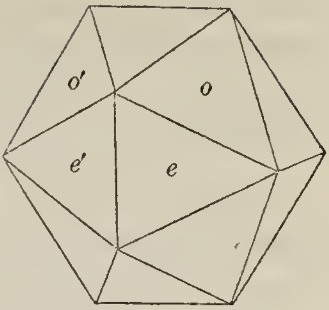


FIG. 192.



Forms and combinations. *a*, *o*, *e‵*, *ao*, *ae‵*, *oe‵*, *aoe‵*, *oe‵s‵*, *aoe‵s‵*. The faces *a* striated parallel to their intersections with *e*; the other faces smooth. Cleavage. *a*, perfect. Fracture imperfect, conchoidal...uneven. Opaque. Lustre metallic. Silver-white, inclining to copper-red; occasionally tarnished. Streak greyish-black. Brittle. H = 5·5. G = 6·1...6·3.

In the matrass unchanged. In the open tube yields a sublimate of arsenious acid and disengages sulphurous acid. On charcoal before the blowpipe emits arsenical fumes and melts into a grey, feebly magnetic globule, which in the outer flame imparts a blue colour to glass of borax. Soluble in warm nitric acid, leaving a residuum of arsenious acid.

$CoS^2 + CoAs$, cobalt 35·54, arsenic 45·17, sulphur 19·29. Part of the cobalt is usually replaced by iron.

Analyses of cobaltine *a* from Skutterud by Stromeyer, *b* from Siegen by Schnabel, from Orawitza in the Banat, *c* by Huberdt, *d* by Patera, *e* from Skutterud by Ebbinghaus, *f* from Siegen by Schnabel :—

	a	*b*	*c*	*d*	*e*	*f*
Cobalt . .	33·10	29·77	30·37	32·03	32·60	8·67
Iron . .	3·23	6·38	5·75	4·56	3·47	25·98
Arsenic .	43·46	44·75	44·13	43·63	43·68	42·53
Antimony.	—	—	—	—	—	2·84
Sulphur .	20·08	19·10	19·75	19·78	20·58	19·98

In imbedded crystals, granular masses and disseminated.

Occurs in beds in crystalline slate rocks with pyrite, towanite, danaite, skutterudite, magnetic iron oxide, accompanied by quartz, mica, amphibole, anthophyllite, calcite. The crystals are sometimes imbedded singly or in small groups in copper and iron pyrites, or attached to skutterudite. Is found at Skutterud in the parish of Modum in Norway, Tunaberg and Hakansbö in Sweden, occasionally at Querbach in Silesia, and Orawitza in the Banat.

79. GERSDORFFITE.—Disomose; Beudant. Eutomer Kobalt-Kies (in part); Mohs. Nickelglanz; Hausmann. Gersdorffit; Haidinger.

Cubic.

a 100, *o* 111, *e* 120. The form *e* is hemihedral with parallel faces.

aa′	90°	0′	
oo′	70	82	(fig. 190.)
oa	54	44	
ea′	26	34	

Form and combination. *o*, *ao*. Cleavage. *a*, tolerably perfect. Fracture uneven. Opaque. Lustre metallic. Light lead-grey, inclining to tin-white; acquires a greyish-black or iridescent tarnish by exposure. Streak greyish-black. Brittle. H = 5·0...5·5. G = 6·1...6·13.

Decrepitates in the matrass. In the open tube yields a yellowish-brown sublimate of sulphuret of arsenic. The reactions of the residue are the same as those of kupfernickel. Before the blowpipe on charcoal deposits a white sublimate, and fuses into a black, brittle globule, which imparts a green colour to glass of borax. Partially soluble in nitric acid, leaving a residue of sulphur and arsenious acid.

Analyses of gersdorffite *a* from Loos by Berzelius, *b* from Haueisen near Lobenstein, *c* from Harzgerode (G = 5·61...5·65) both by Rammelsberg, *d* in crystals from Schladming, the mean of three analyses, and *e* from Prakendorf by Löwe, *f* from Müsen, in octahedrons, by Schnabel:—

	a	*b*	*c*	*d*	*e*	*f*
Nickel . .	30·21	31·82	30·30	26·14	28·75	32·66
Iron . .	4·15	—	6·01	9·55	8·90	2·38
Cobalt . .	0·92	antimony	0·86	—	—	—
Arsenic .	45·78	48·02	44·01	49·83	46·10	46·02
Sulphur .	19·51	20·16	18·83	14·13	16·25	18·94

In crystals and granular or lamellar masses.

Is found at Harzgerode and Tanne in the Harz, Schladming in Stiria, Kamsdorf, Lobenstein in Voightland, near Loos in Helsingland in Sweden, Prakendorf in Hungary, in Spain and in the Brazils.

A mineral from Lichtenberg near Steben in the Fichtelgebirge, v. Kobell's 'amoibite,' occurring in crystals belonging to the cubic system, G = 6·08, consists according to v. Kobell of:

Nickel 37·34, cobalt trace, iron 2·50, lead 0·82, arsenic 45·34, sulphur 14·00.

An arsenical nickel from the Hasselhäue mine near Tanne in the Harz, according to the analysis of E. Hoffmann, consists of: nickel 30·02, cobalt 0·56, iron 3·29, arsenic 53·60, sulphur 11·05.

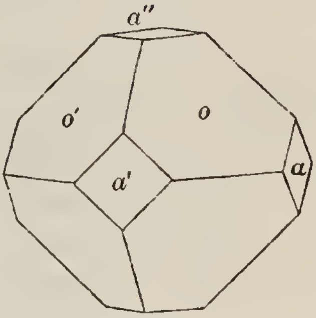
80. ULLMANNITE.—Nickel antimonié sulfuré; Dufrénoy. Eutomer Kobalt Kies (in part); Mohs. Antimonnickelglanz; Hausmann. Ullmannit; Haidinger.

Cubic.

a 100, *o* 111, *d* 011.

aa′	90°	0′
oo′	70	32
dd′	60	0
oa	54	44
da′	45	0

FIG. 193



Combinations. *ao*, *aod*. Cleavage. *a*, perfect. Opaque. Lustre metallic. Lead-grey...steel-grey; acquires a greyish-black or variegated tarnish by exposure. Streak greyish-black. Brittle. H = 5·0...5·5. G = 6·2...6·55.

In the open tube yields sulphurous acid and a sublimate of oxide of antimony. Before the blowpipe on charcoal fumes abundantly, emitting a faint smell of arsenic, and melts into a brittle metallic globule, which frequently tinges glass of borax blue. Decomposed by concentrated nitric acid, leaving a residue of sulphur, oxide of antimony, and arsenious acid. Partially soluble in nitromuriatic acid, forming a green solution, and leaving a residue of sulphur.

$NiSb + NiS^2$, nickel 26·84, antimony 58·62, sulphur 14·54, a portion of the antimony being sometimes replaced by arsenic.

Analyses of ullmannite *a* from Eisern by Ullmann, *b* from Freusburg by Klaproth, *c* from Sayn-Altenkirchen by John, *d*, *e* from Landskrone by H. Rose, *f* from Harzgerode (G = 6·506) by Rammelsberg:

	a	*b*	*c*	*d*	*e*	*f*
Nickel . .	26·10	25·25	23·33	27·36	28·04	29·43
Iron . .	—	—	—	—	—	1·83
Antimony	47·56	47·75	61·68	55·76	54·47	50·84
Arsenic .	9·94	11·75	—	—	—	2·65
Sulphur .	16·40	15·25	14·16	15·98	15·55	17·38

In crystals and granular masses, disseminated.

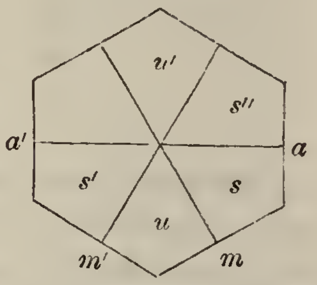
Is found in iron-stone veins, containing copper and lead ores, in the Westerwald; with pyrite, towanite, galena, smaltine, cuprite, malachite, chalybite, in the Jungfrau mine near Gosenbach, Aufgeklärtes Gluck near Eisern, Bandenberg, Landskrone near Willesdorf, Friedrich Wilhelm at Freusburg, the Albertine mine near Harzgerode.

81. ZINCKENITE. — Zinkenite; Dufrénoy. Rhomboedrischer Dystom-Glanz; Mohs. Zinckenit; Hausmann, Haidinger.

Prismatic. 011,010=75° 18′; 101,001=8° 30′; 110,100=60° 19′·5.

uu′	29°	24′
ma	60	20
mm′	59	21
sa	77	18
ua	90	0
s′s″	29	4
ss′	25	24

FIG. 194.



Twins. Twin-face *m*. Fracture uneven. Opaque. Lustre metallic. Dark steel-grey...lead-grey; sometimes iridescent. Streak the same. Slightly brittle. H = 3·0...3·5. G = 5·30...5·35.

In the open tube yields a white sublimate of oxide of antimony and antimonite of lead. Before the blowpipe on charcoal decrepitates, melts and deposits a yellow sublimate of oxide of lead, surrounded by a ring of oxide of antimony, and can be nearly all volatilized, leaving a very small bead containing copper. With soda yields a globule of lead. Decomposed by warm hydrochloric acid, forming chloride of lead.

$\overset{\prime}{\text{Pb}}\overset{\prime\prime\prime}{\text{Sb}}$, lead 34·92, antimony 43·50, sulphur 21·58.

Analysis of zinckenite from Wolfsberg by H. Rose;

Lead	31·84
Copper	0·42
Antimony	44·39
Sulphur	22·58

In attached crystals, forming radiating groups and druses, in columnar masses.

Is found in a vein with antimonite and quartz at Wolfsberg in the Harz, and near St. Trudpert in the Black Forest.

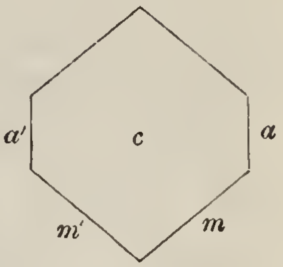
82. JAMESONITE.—Jamesonite; Dufrénoy. Axotomer Antimon-Glanz; Mohs. Jamesonit; Hausmann, Haidinger.

Prismatic.

a 100 cleavage, *c* 001 cleavage, *m* 110.

ac	90°	0′
mc	90	0
ma	50	40
mm′	78	40

FIG. 195.



Cleavage. *c*, very perfect; *m*, *a* less perfect. Opaque. Lustre metallic. Steel-grey. Streak the same. Sectile. H = 2·0...2·5. G = 5·564...5·616.

In the open tube and with acids the reactions are the same as those of zinckenite. Decrepitates when heated. Before the blowpipe melts easily, deposits a sublimate of oxides of lead and antimony on the charcoal, and, after the lead and antimony are driven off, leaves a slag which usually affords the reactions of copper and iron. With soda yields a globule of lead.

$\overset{\prime}{\mathrm{P}}\mathrm{b}^3\overset{\prime\prime\prime}{\mathrm{S}}\mathrm{b}^2$, lead 43·59, antimony 36·21, sulphur 20·20.

Analyses of jamesonite *a* from Valencia d'Alcantara by Schaffgotsch, *b*, *c*, *d* from Cornwall by H. Rose, *e* from Arany-Idka by Löwe:—

	a	*b*	*c*	*d*		*e*
Lead . .	39·97	40·75	40·35	38·71		39·67
Iron . .	3·63	2·30	2·96	2·65		2·91
Copper . .	—	0·13	0·21	0·19		1·73
Zinc . . .	0·42	—	Pb,Fe,Zn	0·74	Zn	0·34
Silver . .	—	—	—	—		1·44
Bismuth .	1·06	—	—	—		0·21
Antimony .	32·62	34·40	33·47	34·90		32·17
Sulphur .	21·78	22·15	undetermined	25·53		18·07

In acicular crystals, parallel or diverging groups, more frequently in fibrous masses.

Is found in Cornwall sometimes with bournonite, at Valencia d'Alcantara in Estremadura, Arany-Idka in Hungary, Carcassone and Pont Vieux in France, Nertschinsk in Siberia, Catta-Franca in the Brazils.

The substance called 'bleischimmer' is supposed to be jamesonite. Opaque. Lustre metallic. Light lead-grey. Acquires a blackish tarnish. Streak shining. Soft. Sectile. G =

5·95. Before the blowpipe emits a smell of sulphur and arsenic, and melts into a metallic globule, depositing a white and a red sublimate upon the charcoal. Analysis by Pfaff:— Lead 43·44, iron 0·16, copper 0·18, arsenic 3·56, antimony 35·47, sulphur 17·20. Is found in fine-grained masses with towanite at Nertschinsk in Siberia.

83. PLUMOSITE.—Antimoine sulfuré capillaire; Hauy. Federerz; Hausmann. Plumosit; Haidinger.

Opaque. Lustre metallic, feeble. Blackish lead-grey...steel-grey. Sectile. H = 3·0. G = 5·7...5·9.

$\overset{\prime}{\mathrm{P}}\mathrm{b}^2\overset{\prime\prime\prime}{\mathrm{S}}\mathrm{b}$, lead 49·77, antimony 31·01, sulphur 19·22.

Analyses of fibrous plumosite by H. Rose, of a massive variety by Poseleger, both from Wolfsberg:—

Lead	46·87	48·48
Iron	1·30	—
Zinc	0·08	—
Antimony	31·04	32·98
Sulphur	19·72	20·32

Before the blowpipe melts easily, and is volatilized, with the exception of a small slag-like residue, depositing a sublimate of oxides of lead and antimony upon the charcoal. With soda yields a globule of lead.

Is found in fine flexible and elastic acicular or capillary crystals in veins with antimonite, galena, &c. in the Harz, at Wolfsberg, Pfaffenberg, and Meiseberg near Neudorf.

The substance known by the name of dark zundererz from the Catharina Neufang mine at Andreasberg, according to Bornträger, consists of

Silver	2·56
Lead	43·06
Iron	4·52
Antimony	16·88
Arsenic	12·60
Sulphur	19·57

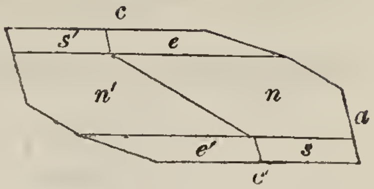
84. PLAGIONITE. — Plagionite; Dufrénoy. Hemiprismatischer Dystom-Glanz; Mohs. Plagionit; Hausmann, Haidinger.

Oblique. 101,100=54° 51; 111,010=71° 1′·5; 101,001=17° 37′.

a 100, *c* 001, *e* 111, *s* $11\bar{1}$, *n* 221.

ca	72° 28′	*ec*	25° 40′
nn′	120 49	*nc*	41 8
ee′	142 3	*sc*	149 0
ss′	134 30		

FIG. 196.



The faces *c* smooth; *e*, *s*, *n* striated parallel to their intersections with each other, the faces *a* striated parallel to their intersections with *c*. Cleavage. *n* tolerably perfect. Fracture imperfect conchoidal. Opaque. Lustre metallic. Blackish lead-grey. Streak the same. Brittle. H = 2·5. G = 5·4.

Decrepitates violently when heated. In the open tube emits fumes of antimony and sulphurous acid. Before the blowpipe melts very easily on charcoal, sinks into the charcoal, and at last yields a globule of lead.

$\overset{\prime}{\mathrm{Pb}}{}^4\overset{\prime\prime\prime}{\mathrm{Sb}}{}^3$, lead 41·04, antimony 38·35, sulphur 20·61.

Analyses of plagionite from Wolfsberg by H. Rose and Kudernatsch:—

Lead	40·52	40·98
Antimony . .	37·94	37·53
Sulphur . . .	21·53	21·49

Is found in small attached crystals, collected in druses, and granular masses, in a vein in quartz with plumosite, bournonite, kermes, at Wolfsberg in the Harz.

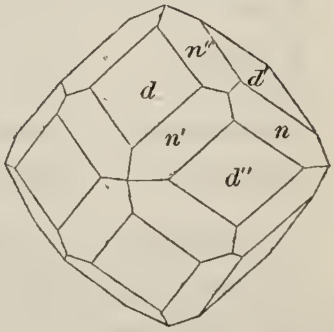
85. DUFRÉNOYSITE.—Dufrénoysit; Damour. Ann. de Chim. 3. S. 14, 379; Hausmann.

Cubic.

d 001, *n* 211.

dd′	60° 0′
nn′	33 33
dn′	30 0

FIG. 197.



Combination. *dn*. No cleavage observable. Fracture uneven. Opaque. Lustre metallic. Steel-grey. Streak reddish-brown. Brittle. G = 5·549. In the matrass yields a sublimate of sulphide of arsenic.

Before the blowpipe on charcoal melts readily, emitting fumes of arsenic and sulphur, and yields a globule of lead. Soluble in borax and salt of phosphorus. Is decomposed by hot concentrated nitric acid.

$\overset{\prime}{\mathrm{Pb}}{}^2\overset{\prime\prime\prime}{\mathrm{As}}$, lead 57·21, arsenic 20·69, sulphur 22·10.

Analyses by Damour:—

Lead	55·40	56·61
Silver . . .	0·21	0·17
Copper . . .	0·30	0·22
Iron	0·44	0·32
Arsenic . . .	20·69	20·87
Sulphur . . .	22·49	22·30

In crystals and disseminated.

Is found with realgar, blende and pyrite, in narrow veins in the dolomite of St. Gotthardt.

86. BOULANGERITE.—Boulangerit; Hausmann, Haidinger.

Opaque. Lustre metallic, inclining to silky. Blackish lead-grey. Streak darker. Slightly brittle. H=3·0. G=5·96...6·0.

Before the blowpipe melts easily, emits sulphurous acid and fumes of antimony, and deposits a sublimate of oxide of lead upon the charcoal. Soluble in warm hydrochloric acid, with evolution of hydrosulphuric acid.

$\overset{\prime}{\mathrm{Pb}}{}^3\overset{\prime\prime\prime}{\mathrm{Sb}}$, lead 57·99, antimony 24·09, sulphur 17·92.

Analyses of boulangerite *a* from Molières by Boulanger, *b* from Nasafjeld by Thaulow, *c* from the Staroserentnische mine by Bromeis, *d* from the Ljurgenskische mine by Bruël, *e* from Ober-Lahr by Abendroth, *f* from Wolfsberg by Rammelsberg.

	a	*b*	*c*	*d*	*e*	*f*
Lead . .	53·9	55·57	56·29	53·87	55·60	55·15
Iron . .	1·2	—	—	1·78	—	—
Copper . .	0·9	—	—	—	—	—
Silver . .	—	—	—	0·05	—	—
Antimony .	25·5	24·60	25·04	23·66	25·40	25·94
Sulphur .	18·5	18·86	18·22	19·11	19·05	18·91

In granular, columnar or fibrous masses.

Is found at Molières in France, Ober-Lahr in Sayn. Altenkirchen, Nasafjeld in Lapland, in the Staroserentnische and Ljurgenskische mines near Nertschinsk in Siberia.

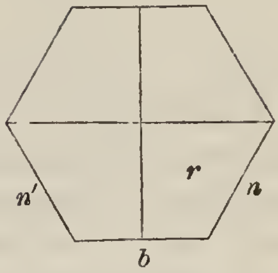
87. SCHULZITE.—Geokronite; Dufrénoy. Geokronit, Schulzit; Hausmann, Haidinger.

Prismatic.

b 010, *n* 210, *r* 111.

nb	59°	52′
nn′	119	44

FIG. 198.



Cleavage. *n*. Fracture conchoidal...even. Opaque. Lustre metallic. Lead-grey. Streak the same. Brittle. H = 2·5...3·0. G = 5·8 ...6·54.

Melts very easily before the blowpipe, and affords the reactions of arsenic, antimony and lead.

$\overset{\prime}{Pb}{}^5\overset{\prime\prime\prime}{Sb}$, lead 66·83, antimony 16·65, sulphur 16·52, a large proportion of the antimony being sometimes replaced by arsenic.

Analyses of schulzite *a* from Mérédo by Sauvage, *b* of the variety called geokronite from Sahla by Svanberg, *c* from Val di Castello by Kerndt:—

	a	*b*	*c*
Lead . . .	64·89	66·45	66·54
Copper . .	1·60	1·51	1·53
Iron . . .	—	0·42	—
Zinc . . .	—	0·11	—
Antimony .	16·00	9·58	9·69
Arsenic . .	—	4·69	4·72
Sulphur . .	16·90	16·26	17·32

Very seldom crystallized, usually massive.

Is found in galena at Mérédo in the province of Gallicia in Spain, at Val di Castello near Pietrosanto in Tuscany, the geokronite in the silver mine of Sahla in Sweden.

Kilbrickenite is supposed by Rammelsberg to be schulzite. Blueish-grey. H = 2·0...2·5. G = 6·407.

Slowly soluble in warm hydrochloric acid.

Analysis by Apjohn:—

Lead	68·87
Iron	0·38
Antimony	14·39
Sulphur	16·36

Is found at Kilbricken in the county of Clare in Ireland.

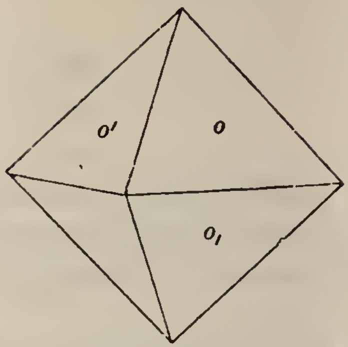
88. STEINMANNITE.—Oktaedrischer Blei-Glanz; Mohs. Steinmannit; Hausmann, Haidinger.

Cubic.

a 100 cleavage, *o* 111.

aa′	90°	0′
oo′	70	32
oa	54	44

FIG. 199.



Cleavage. *a*, imperfect. Fracture uneven. Opaque. Lustre metallic. Lead-grey. Streak grey, shining. Sectile. H = 2·5. G = 6·833.

In the matrass decrepitates and falls into powder. Before the blowpipe on charcoal emits sulphurous acid, fumes and deposits a sublimate of oxide of antimony upon the charcoal, and after prolonged exposure to the flame leaves a globule of lead, which by cupellation yields a globule of silver.

$\overset{\prime}{\mathrm{Pb}},\overset{\prime\prime\prime}{\mathrm{Sb}}$, sulphides of lead and antimony in unknown proportions.

In botryoidal and reniform masses, the surfaces of which are studded with crystals.

Is found at Przibram in Bohemia with silver, blende, pyrite and quartz.

89. BERTHIERITE.—Berthierite; Dufrénoy. Berthierit; Mohs, Hausmann, Haidinger.

Cleavage in several directions, indistinct. Fracture uneven. Opaque. Lustre metallic. Iron-black, dark steel-grey, inclining to yellowish or reddish; liable to tarnish. H = 2·0...3·0. G = 4·0...4·3.

Before the blowpipe on charcoal melts readily, yields fumes of antimony, and leaves a black magnetic slag. Soluble in hydrochloric acid, more readily in nitromuriatic acid.

$\overset{\prime}{\mathrm{Fe}}\overset{\prime\prime\prime}{\mathrm{Sb}}$, iron 12·30, antimony 58·51, sulphur 29·19.

Analyses of berthierite *a* from Chazelles, *b* from Martouret mine in Auvergne, *c* from Anglar, all by Berthier; *d*, *e* from Bräunsdorf by Rammelsberg, *f* from Arany-Idka by v. Pettko:—

	a	*b*	*c*	*d*	*e*	*f*
Iron . . .	16·0	9·85	12·17	11·96	11·43	12·85
Zinc . . .	0·3	—	—	trace	0·74	—
Manganese .	—	—	—	0·46	2·54	—
Antimony .	52·0	61·34	58·65	54·34	54·70	57·88
Sulphur . .	30·3	28·81	29·18	30·57	31·33	29·27

Is found in crystalline columnar masses in a vein in gneiss near Chazelles in Auvergne, Anglar in the department of la Creuse, Bräunsdorf near Freiberg in Saxony, and Arany-Idka in Hungary.

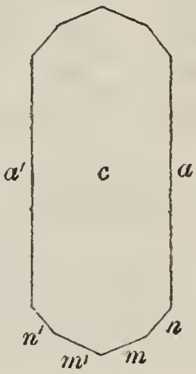
90. **WOLFSBERGITE.** — Kupferantimonglanz; Mohs, Hausmann, Haidinger.

Prismatic.

a 100, *c* 001 cleavage, *m* 110, *n* 210.

ac	90°	0′
na	50	30
ma	67	36
nn′	79	0
mm′	44	48

FIG. 200.



The faces *a* large, striated parallel to their intersections with *m*. Cleavage. *a*, very perfect; *c*, less perfect. Fracture conchoidal...uneven. Opaque. Lustre metallic. Lead-grey, inclining to iron-black; sometimes has an iridescent tarnish. Streak black, dull. H = 3·5. G = 4·748.

Decrepitates when heated. Before the blowpipe melts easily, and deposits a white sublimate on the charcoal, leaving a hard metallic globule which with soda yields a bead of copper.

$\overset{\prime}{\cancel{\text{C}}}\text{u}\overset{\prime\prime\prime}{\text{S}}\text{b}$, copper 24·71, antimony 50·33, sulphur 24·96.

Analysis by H. Rose:—

Copper	24·46
Iron	1·39
Lead	0·56
Antimony . . .	46·81
Sulphur . . .	26·34

Is found with quartz, towanite, zinckenite, antimonite, at Wolfsberg in the Harz.

91. **BOURNONITE.**—Bournonite; Phillips. Antimoine sulfuré plumbo-cuprifère; Hauy. Diprismatischer Dystom-Glanz; Mohs. Bournonit; Hausmann, Haidinger.

Prismatic. 011,010=46° 17′; 101,001=41° 53′·5; 110,100=46° 50′.

a 100, *b* 010, *c* 001, *z* 021, *o* 011, *h* 023, *x* 012, *t* 014, *n* 101, *e* 120, *l* 230, *m* 110, *w* 430, *f* 210, *y* 111, *s* 122, *v* 121, *u* 112, *r* 314.

tc	13°	27′	*yc*	52°	40′	*ua*	67°	58′
xc	25	33	*ya*	57	3	*va*	67	26
hc	32	31	*sa*	72	3	*ra*	56	49
oc	43	43	*vb*	35	5	*rb*	78	47
zc	62	24	*yb*	54	33	*rc*	35	31
bc	90	0	*sb*	48	54	*oo′*	87	26
nc	41	54	*ub*	66	26	*nn′*	83	47
ac	90	0	*sc*	46	34	*mm′*	86	20
eb	25	8	*vc*	64	40			
lb	32	1						
mb	43	10						
wb	51	21						
fb	61	56						
ab	90	0						
uc	33	15						

FIG. 201.

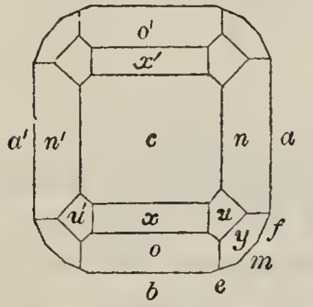
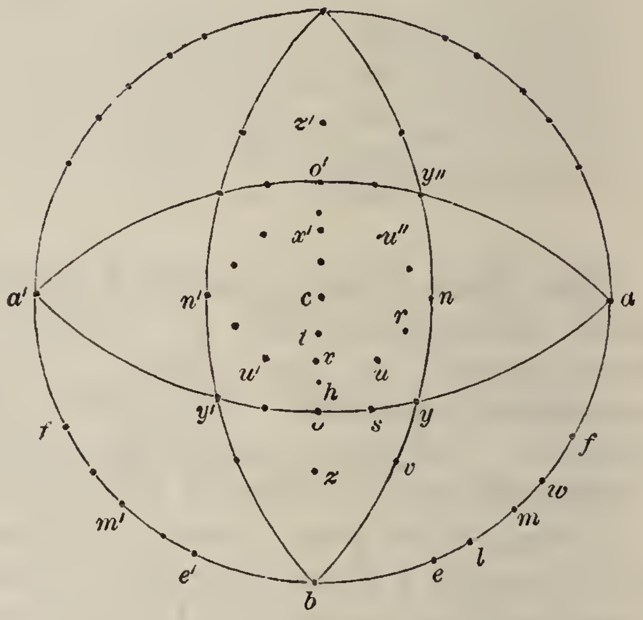


FIG. 202.



Combinations. *bomca, bounac, bouymnac, bemfoyuxnac.* Twins. Twin-face *m*. Cleavage. *a*, indistinct; *b, c* less distinct; *o, n* traces. Fracture conchoidal...uneven. Opaque. Lustre metallic. Steel-grey, inclining to lead-grey or iron-black. Streak the same. Brittle. H = 2·5...3·0. G = 5·70...5·87.

Decrepitates when heated. In the open tube disengages sulphurous acid, and deposits a volatile sublimate of oxide of antimony on the upper part of the tube, and on the lower part a sublimate of antimonite of oxide of lead, which is infusible and not volatile. Before the blowpipe on charcoal melts, emits fumes, leaves a black globule which, exposed to a strong heat, deposits a yellow sublimate of oxide of lead, and after the lead has been driven off, with soda yields a globule of copper. Partially soluble in nitric acid, forming a blue solution, and leaving a residue of oxide of antimony and sulphur.

$\overset{\prime}{\not{C}}u^{3}\overset{\prime\prime\prime}{S}b + 2\overset{\prime}{P}b^{3}\overset{\prime\prime\prime}{S}b$, lead 41·80, copper 12·79, antimony 26·94, sulphur 19·37.

Analyses of bournonite from Neudorf *a* by H. Rose, *b* by

Sindig, *c* from Meiseberg (G = 5·703...5·792) by Bromeis, from Neudorf (G = 5·822...5·863), *d* by Bromeis, *e* by Rammelsberg, from Wolfsberg (G = 5·726...5·855), *f* by Bromeis, *g* by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Lead . . .	40·84	41·38	40·04	40·42	41·83	42·88	41·92
Copper . .	12·65	12·68	15·16	13·06	13·48	13·06	12·38
Antimony .	26·28	25·68	24·82	24·60	24·54	24·34	26·08
Sulphur . .	20·31	19·63	18·99	19·49	20·15	19·76	19·62

In *e* and *g* the antimony was deduced from the loss.

In crystals, granular masses, and disseminated.

Occurs in veins in slate rocks, with galena, antimonite, blende, towanite, mispickel, quartz, chalybite, dolomite. Is found near Neudorf, Wolfsberg, Clausthal and Andreasberg in the Harz, Bräunsdorf and Gross Voigtsberg in Saxony, Ober Lahr in Sayn-Altenkirchen, Kapnik and Offenbanya in Transylvania, Neusohl in Hungary, Servoz in Savoy, Alais and Pontgibaud in France, Brozzo in Piedmont, Huel Boys and Nanslo near Redruth in Cornwall, Beeralstone in Devonshire, Siberia, Potosi, Guanaxuato in México.

92. WÖLCHITE.—Prismatoidischer Dystom-Glanz; Mohs. Antimonkupferglanz; Hausmann. Wölchit; Haidinger.

Prismatic.

a 100, *b* 010, *c* 001, *m* 110, *e* 011.

Cleavage. *a*, imperfect. Fracture imperfect conchoidal. Opaque. Lustre metallic. Blackish lead-grey. Streak the same. Brittle. H = 3·0. G = 5·7...5·8.

Before the blowpipe on charcoal fuses with ebullition, deposits first a white and then a yellow sublimate, yields a lead-grey metallic globule, which, after prolonged roasting, with soda yields a globule of copper.

Analysis by Schrötter:—

Lead	29·90
Copper	17·35
Iron	1·40
Antimony	16·65
Arsenic	6·04
Sulphur	28·60

Is found in crystals and massive, in a bed of chalybite with pyrite, antimonite and galena at St. Gertraud in the Lavantthal in Carinthia.

93. KOBELLITE.—Kobellite; Dufrénoy. Kobellit; Hausmann, Haidinger.

Opaque. Lustre metallic. Dark lead-grey. Streak black. G = 6·29...6·32.

In the open tube yields sulphurous acid and oxide of antimony. Before the blowpipe melts with ebullition, deposits a white and a yellow sublimate upon the charcoal, and leaves a white metallic bead. Soluble in concentrated hydrochloric acid with disengagement of hydrosulphuric acid.

Analysis by Setterberg:—

Lead	40·12
Bismuth	27·05
Iron	2·96
Copper	0·80
Antimony	9·25
Sulphur	17·86
Earthy matter . . .	1·45

In radiating, columnar and fibrous masses.

Is found in the cobalt mine of Hvena in the province of Nerike in Sweden with cobaltine, mispickel, towanite.

94. TENNANTITE.—Tennantite; Phillips. Cuivre gris (in part); Hauy. Dodekaedrischer Dystom-Glanz; Mohs. Tennantit; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *n* 211, *z* 322. *o*, *n*, *z* are hemihedral with inclined faces.

aa′	90°	0′	*dd′*	60°	0′	*na*	35°	16′
oo′	70	32	*da′*	45	0	*nd′*	30	0
oo,,	109	28	*do*	35	16	*zo*	11	39
oa	54	44	*no*	19	28			

FIG. 203.

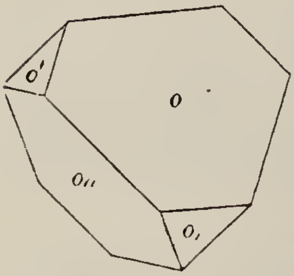


FIG. 204.

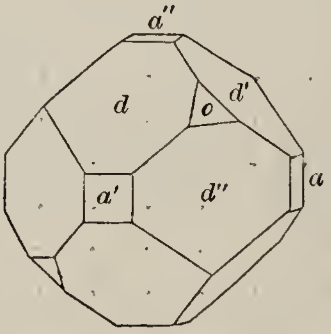
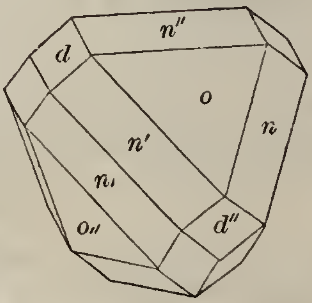


FIG. 205.



Combinations. *o′o,*, *ado′*, *do′n′*. Twins. Twin-face *o*. Cleavage. *d*, imperfect. Fracture uneven. *d* striated parallel to the intersections with *o*. Opaque. Lustre metallic. Blackish lead-grey…iron-black. Streak dark reddish-grey. Brittle. H = 4·0. G = 4·3…4·5.

Before the blowpipe emits arsenical fumes, and melts into a black magnetic bead.

$(\acute{F}e^4, \acute{\cancel{C}}u^4)\overset{'''}{A}s$, part of the $\acute{F}e$ being replaced by $\acute{C}u$.

Analysis by Kudernatsch:—

Copper	48·94
Iron	3·57
Arsenic	19·10
Sulphur	27·76
Silver	trace
Quartz	0·08

In small attached crystals, rarely massive, on other ores of copper, in veins in granite and clay slate, with pyrite, towanite, redruthite, bornite, kupferschwärze, near Redruth and St. Day in Cornwall.

Breithaupt's 'kupferblende' from Freiberg appears to be a variety of tennantite containing zinc. Streak red. H = 3·5…4. G = 4·2…4·4.

$(\acute{F}e^4, \acute{Z}n^4, \acute{\cancel{C}}u^4)\overset{'''}{A}s$.

Analysis by Plattner:—

Copper	41·07
Zinc	8·94
Iron	2·22
Lead	0·34
Arsenic	18·88
Sulphur	28·11
Silver and antimony .	traces

95. FAHLERZ. — Grey copper; Phillips. Cuivre gris (in part); Hauy. Tetraedrischer Dystom-Glanz; Mohs. Fahlerz; Hausmann. Tetraedrit; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *f* 310, *n* 211, *m* 311, *y* 233, *s* 321. *o*, *n*, *m*, *y* are hemihedral with inclined faces.

aa′	90°	0′	*nd′*	30°	0′	*sa*	36°	42′
oa	54	44	*yo*	10	11	*so*	22	13
dd′	60	0	*yd*	44	33	*ma*	25	14
da′	45	0	*na*	35	19	*mo*	29	30
do	35	16	*fa*	18	26			
no	19	28	*fd*	26	34			

FIG. 206.

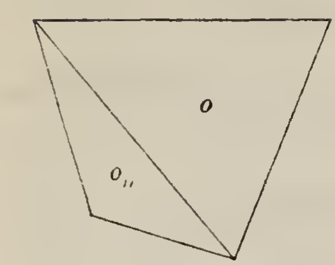


FIG. 207.

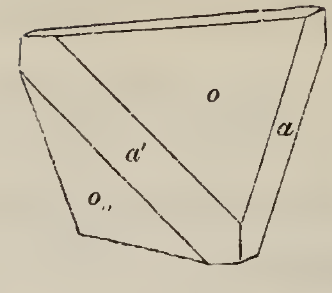


FIG. 208.

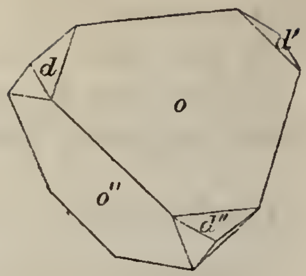


FIG. 209.

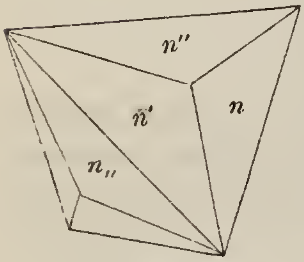


FIG 210.

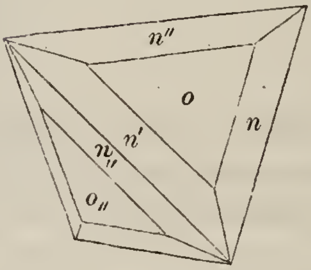
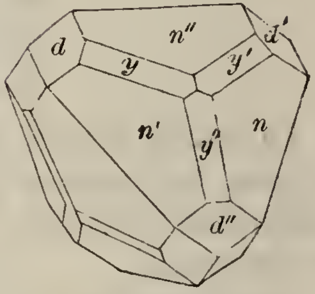


FIG. 211.



Forms and combinations. *o′*, *n′*, *o′o‵*, *ao′*, *o′d*, *o′n′*, *o′n‵*, *dn′*, *ado′*, *adn′*, *do‵n‵*, *dn′y′*, *do′o‵n′*, *adn′n‵*, *ado′n′*, *ado′o‵n′m′*, *ado′fn′n‵*. *o′*, *n′* striated parallel to their intersections with each other; *d*, sometimes rough; the smaller of the faces *o′*, *o‵* very rough. Twins. Twin-face *o*. Cleavage. *o*, imperfect; sometimes faint traces of cleavage parallel to *a* and *d*. Fracture conchoidal ...uneven. Opaque. Lustre metallic. Steel-grey...iron-black. Streak black...dark red. Rather brittle. H = 3·0...4·0. G = 4·5...5·2.

In the open tube yields fumes of antimony, sulphurous acid, and sometimes arsenic. Before the blowpipe on charcoal decrepitates, emits the smell of burning sulphur, deposits a sublimate on the charcoal, and melts easily with slight ebullition into a steel-grey slag, which is usually magnetic, and with borax melts into a grey metallic globule, which with soda yields a globule of copper. In powder is decomposed by nitric acid with disengagement of nitrous acid and separation of oxide of antimony, arsenious acid and sulphur; the solution has a brownish-green colour. In powder is partially decomposed by caustic potash, which dissolves out the sulphides of antimony and arsenic; the alkaline solution yields an orange-red or lemon-yellow precipitate on the addition of an acid.

$(\overset{\prime}{\mathrm{Pb}}{}^4,\overset{\prime}{\mathrm{Fe}}{}^4,\overset{\prime}{\mathrm{Zn}}{}^4,\overset{\prime}{\mathrm{Cu}}{}^4)\overset{\prime\prime\prime}{\mathrm{Sb}}$, a portion of the bases being frequently replaced by $\overset{\prime}{\mathrm{Hg}}$ and $\overset{\prime}{\mathrm{Ag}}$, and a portion of the $\overset{\prime\prime\prime}{\mathrm{Sb}}$ by $\overset{\prime\prime\prime}{\mathrm{As}}$. The varieties which contain a large proportion of arsenic are not so dark as those which contain little or no arsenic. In the varieties containing zinc the streak is red.

Analyses of fahlerz *a* from Kapnik, *b* from Gersdorf near Freiberg, *c* from Markirchen in Alsace, *d* from the Aurora mine in Dillenburg, *e* from the Zilla mine near Clausthal, *f* from the St. Wenzel mine near Wolfach, all by H. Rose:—

	a	*b*	*c*	*d*	*e*	*f*
Copper . .	37·98	38·63	40·60	38·42	34·48	25·23
Silver . .	0·62	2·37	0·60	0·83	4·97	17·71
Iron . .	0·86	4·89	4·66	1·52	2·27	3·72
Zinc . .	7·29	2·76	3·69	6·85	5·55	3·10
Antimony .	23·94	16·52	12·46	25·27	28·24	26·63
Arsenic . .	2·88	7·21	10·19	2·26	—	—
Sulphur .	25·77	26·33	26·83	25·03	24·73	23·52

Analyses of fahlerz *g* from Kotterbach near Iglo in Hungary by Scheidthauer, *h* from the valley of Angina in Tuscany (G = 4·84) by Kersten; *i* from Schwatz (G = 5·107) by Weidenbusch; *k* from the Habacht mine near Freiberg by H. Rose, *l* from Clausthal by Sander, *m* from the Meiseberg (G = 4·852) by Rammelsberg:—

	g	*h*	*i*	*k*	*l*	*m*
Copper . .	36·94	35·90	34·86	14·81	35·7	30·47
Mercury .	7·73	2·70	15·70	lead	0·9	0·78
Silver . .	trace	0·33	—	31·29	8·9	10·48
Iron . . .	5·04	1·93	2·26	5·98	4·5	3·52
Zinc . . .	1·04	6·24	1·35	0·99	—	3·39
Antimony .	19·02	27·47	21·53	24·63	26·8	26·56
Arsenic . .	4·09	—	—	—	—	—
Sulphur . .	24·00	23·40	23·15	21·17	24·1	24·80

In crystals attached and aggregated in druses; massive and disseminated.

Occurs in beds with towanite, chalybite, quartz; in veins with galena, blende, and baryte. Is found at Andreasberg, Clausthal, Goslar and Zellerfeld in the Harz, Neudorf in Anhalt, Dillenburg in Nassau, Falkenstein near Schwatz in the Tyrol, Kapnik in Transylvania, Schemnitz, Kremnitz and Schmölnitz in Hungary, Wolfach and Schriessheim in Baden, Drkolnow near Przibram in Bohemia, in Stiria, Freyberg in Saxony, Mansfeld, Saalfeld and Kamsdorf, in the Vosges, Beresow near Katharinenburg in Siberia, Mexico, Chile, Chivato in Peru, Cook's Kitchen and Crinnis (sparingly) in Cornwall; Tavistock and Beeralstone in Devonshire, Fassney Burn in East Lothian, Airthrie in the Ochil hills in Scotland, Mainland Shetland.

Analyses *n* of weissgültigerz (according to Rammelsberg a variety of fahlerz) from Freiberg by Fournet, *o* from the Hoffnung Gottes mine near Freiberg (G = 5·438…5·465) by Rammelsberg:—

	n	*o*
Copper . . .	—	0·32
Lead	38·30	38·36
Silver . . .	20·00	5·78
Iron	—	3·83
Zinc	—	6·97
Antimony . .	23·85	22·39
Sulphur . . .	17·85	22·53

96. FREIESLEBENITE.—Mine d'argent grise antimoniale; Romé de Lisle. Sulphuret of silver and antimony; Phillips. Peritomer Antimon-Glanz; Mohs. Schilfglaserz; Hausmann. Freieslebenit; Haidinger.

Oblique. 101,100 = 31° 41′; 111,010 = 64° 1′; 101,001 = 56° 5′.

a 100, *c* 001, *w* 021, *v* 032, *r* 011, *u* 012, *x* 101, *k* 120, *n* 350, *l* 560, *m* 110, *s* 430, *t* 310, *f* 111, *y* 112, *z* 212, *g* 312, *h* 414.

uc	24°	52′	*hx*	6°	57′	*xc*	56°	5′
rc	42	50	*zx*	13	42	*uu′*	130	16
vc	54	17	*fx*	25	59	*rr′*	94	20
wc	61	39	*ga*	24	35	*vv′*	71	26
xa	31	41	*za*	34	14	*ww′*	56	42
ca	87	46	*ya*	53	2	*kk′*	80	52
ta	11	4	*ua*	87	58	*mm′*	119	12
sa	23	36						
ma	30	24						
la	35	9						
na	44	21						
ka	49	34						

FIG. 212.

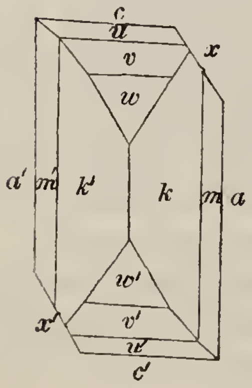
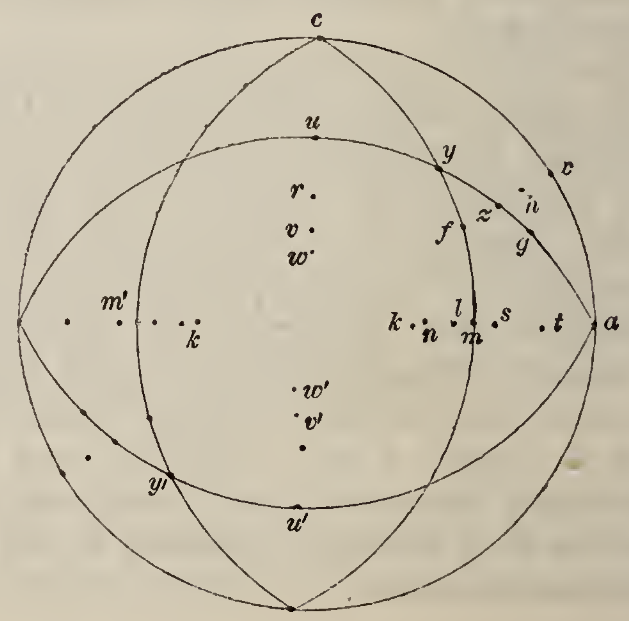


FIG. 213.



Combinations. *awvuxkmsgzy*, *awvruxklmtfgzy*. The faces of the zone *ka* deeply striated parallel to their intersections with each other. Twins. Twin-face *a*. Cleavage. *m*?, *k*? Fracture uneven. Opaque. Lustre metallic. Steel-grey. Streak the same. Brittle. H = 2·5. G = 6·19...6·38.

Before the blowpipe on charcoal deposits a sublimate of oxides of lead and antimony, and yields a globule of silver, which sometimes imparts the colour of copper to borax.

$\overset{\prime}{R}\overset{\prime\prime\prime}{S}b + 2\overset{\prime}{R}^3\overset{\prime\prime\prime}{S}b$, where $\overset{\prime}{R}$ is $\overset{\prime}{A}g$ or $\overset{\prime}{P}b$.

Analyses by Wöhler:—

Silver	23·76	22·18	22·85
Lead	30·08	30·00	31·74
Iron	—	0·11	—
Copper . . .	—	1·22	—
Antimony . .	27·05	27·72	not determined
Sulphur . . .	18·71	18·77	not determined

In crystals, massive and disseminated.

This very rare mineral is found in veins in gneiss with galena, antimonite, pyrargyrite, pyrite, chalybite, calcite, quartz, in the Himmelsfürst and some other mines near Freiberg in Saxony. It is said to have been found at Kapnik in Transylvania and (a variety containing bismuth) at Ratieborzitz in Bohemia.

Freieslebenite was supposed to be prismatic. Some very good crystals, however, in Mr. Brooke's collection, from which the preceding measurements were obtained, evidently belong to the oblique system. According to Phillips, the angle between the cleavages is 100° 0′. He probably measured the angle between *m* and *k*′, which is 100° 2′.

97. POLYBASITE.—Polybasite; Dufrénoy. Rhomboedrischer Melan-Glanz; Mohs. Polybasit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 70° 31′.

o 111, *a* 01$\bar{1}$, *x* 120.

ao	90°	0′
aa	60	0
xo	58	30
xx	50	28

FIG. 214.

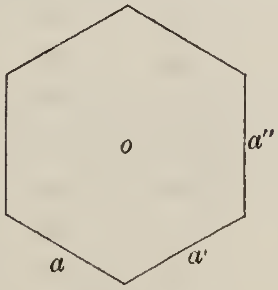
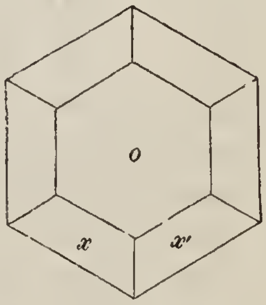


FIG. 215.



Combinations. *oa*, *ox*. The faces *o*, *a* striated parallel to their intersections with each other. Cleavage.

o, imperfect. Fracture uneven. Opaque. Lustre metallic. Iron-black. Streak the same. Sectile. H = 2·5. G = 6·082...6·218.

Decrepitates when heated. In the open tube yields a white sublimate and a smell of sulphurous acid. Before the blowpipe on charcoal melts very easily, and deposits a sublimate of oxide of antimony upon the charcoal. With borax yields a bead of silver containing copper, and imparts a blueish-green colour to borax. Its reactions with acids are the same as those of pyrargyrite and bournonite.

$\overset{\prime}{A}g^9\overset{\prime\prime\prime}{R}$, $\overset{\prime\prime\prime}{R}$ denoting $\overset{\prime\prime\prime}{Sb}$ and $\overset{\prime\prime\prime}{As}$, and a portion of the $\overset{\prime}{Ag}$ being replaced by $\overset{\prime}{\text{Ꞓu}}$.

Analyses of polybasite *a* from Guarisamey, *b* from Schemnitz, *c* from Freiberg, all by H. Rose:—

	a	*b*	*c*
Silver	64·29	72·43	69·99
Copper	9·93	3·04	4·11
Iron	0·06	0·33	0·29
Zinc	—	0·59	—
Arsenic	3·74	6·23	1·17
Antimony	5·09	0·25	8·39
Sulphur	17·04	16·83	16·35

In thin tabular crystals, massive and disseminated.

Is found in veins in crystalline slate and transition rocks, and trachyte, with stephanite, pyrargyrite, blende, towanite, pyrite, quartz, calcite, in several mines near Freiberg in Saxony, Joachimsthal in Bohemia, Schemnitz in Hungary, Guanaxuato and Guarisamey in the province of Durango in Mexico.

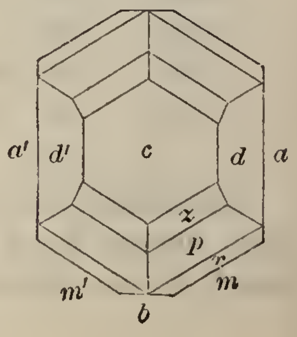
98. STEPHANITE.—Brittle sulphuret of silver; Phillips. Argent antimonié sulfuré noir; Hauy. Prismatischer Melan-Glanz; Mohs. Sprödglaserz; Hausmann. Stephanit; Haidinger.

Prismatic. 011,010=42° 32′·5; 101,001=34° 26′; 110,100=57° 49′·5.

a 100, *b* 010, *c* 001, *e* 101, *d* 201, *m* 110, *p* 111, *r* 221, *z* 112. *e* truncates the edge *cd*.

bc	90°	0′	*mc*	90°	0′
ec	34	26	*za*	73	15
dc	53	54	*zb*	62	44
ac	90	0	*pa*	65	38
ma	57	50	*pb*	48	4
ba	90	0	*ra*	60	15
zc	32	46	*rb*	37	55
pc	52	10	*dd′*	107	48
rc	68	46	*mm′*	64	21

FIG. 216.



Combinations. *cma*, *cpd*, *cpmdaz*, *cpmdazbr*. The faces *m*, *a* striated parallel to their intersections with each other; the other faces smooth. Twins. Twin-face *m*. Cleavage. *d*, *a* imperfect. Fracture conchoidal...uneven. Opaque. Lustre metallic. Iron-black. Streak the same. Sectile. H = 2·5. G = 6·2...6·3.

In the open tube yields a sublimate of oxide of antimony: many varieties yield arsenious acid. Before the blowpipe on charcoal melts into a dark grey bead, which, with soda or borax, in the inner flame yields a globule of silver. Imparts a blueish-green colour to the borax.

$\overset{\prime}{A}g^6\overset{\prime\prime\prime}{S}b$, silver 70·34, antimony 14·02, sulphur 15·64.

Analysis of stephanite from Schemnitz by H. Rose:—

Silver	68·54
Copper	0·64
Antimony	14·68
Sulphur	16·42

In tabular and short columnar crystals; also massive disseminated, investing other minerals; globular with a drusy surface.

Occurs in veins with silver ore in crystalline slate rocks, transition rocks, in trachyte, with arsenic, silver, gold, galena, argentite, towanite, pyrite, quartz, calcite, fluor, baryte. Is found in the mining districts of Freiberg, Schneeberg, Johann-Georgenstadt in Saxony; Joachimsthal, Przibram, Ratieborzitz in Bohemia; Schemnitz, Kremnitz in Hungary; Andreasberg in the Harz; in many places in Mexico.

99. PYRARGYRITE.

— Red silver (in part); Phillips. Argent antimonié sulfuré; Hauy. Rhomboedrische Rubin-Blende (in part); Mohs. Pyrargyrit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 42° 18′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *u* 211, *e* 011, *r* 100, *s* $\bar{1}11$, *m* $3\bar{1}\bar{1}$, *f* $\bar{3}22$, *p* 210, *t* 310, *w* 410, *v* $20\bar{1}$, *y* $30\bar{2}$, *n* $40\bar{1}$, *c* $40\bar{3}$, *d* $21\bar{1}$, *g* $71\bar{2}$, *k* $11\,1\,\bar{4}$, *x* $13\bar{3}$, *i* $51\bar{1}$, *z* $51\bar{2}$.

The forms *b*, *r*, *s* are frequently hemihedral with inclined faces. In combinations of *b*, *r*, those faces of *b* occur which are adjacent to the faces *r* at the unattached end of the crystal.

ao	90°	0′	*ba′*	30°	0′	*ro*	42°	18′
bo	90	0	*bb″*	60	0	*mo*	74	38
aa′	60	0	*uo*	12	49	*eo*	24	28

o = 0R
a = ∞P2
b = ∞R
u = +1/4R
e = −1/2R
r = +R
s = −2R
m = +4R
f = −5R
p = 2/3 P
t = 1/4 R
w = 1/5 R
v = R
y = R
n = R
c = R
d = 1/2 R
g = [illegible]
k = [illegible]

so	61°	13′	*nr*	14°	26′	*db*	54°	27′
fo	82	11	*vr*	29	26	*gr*	15	53
uu′	22	9	*yr*	38	46	*zr*	22	7
rr′	71	18	*cr*	43	10	*rb″*	70	20
mm′	113	14	*ir*	13	8	*ms″*	56	37
ee′	42	2	*dr*	30	15	*vs″*	37	12
ss′	98	46	*rs″*	49	23	*va*	72	24
ff′	118	11	*xa′*	15	57	*va″*	52	48
vo	67	27	*vb*	29	14	*va′*	24	56
yo	75	51						
co	79	46						
zo	54	9						
ko	56	24						
xo	78	16						
wr	12	23						
tr	15	55						
pr	22	22						
re″	35	39						

FIG. 217.

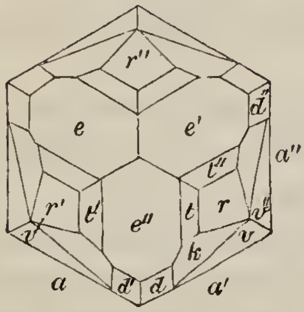
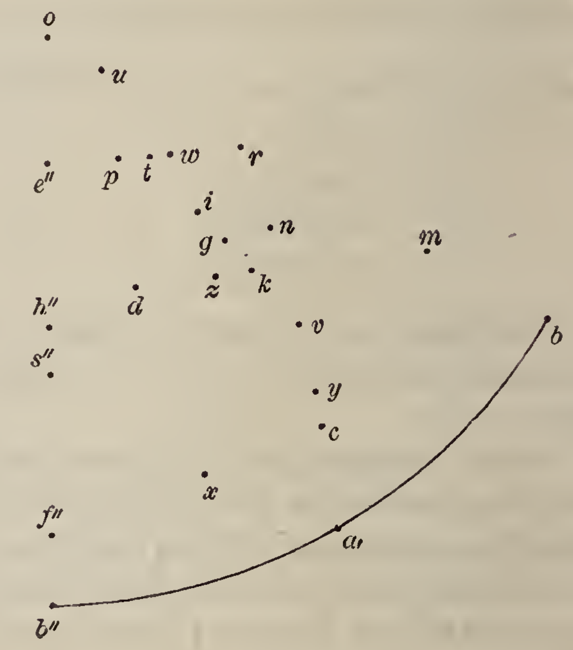


FIG. 218.



Combinations. *oa.e.t.u.v*, *ea.t*, *ra.u..e.t.v.s*, *ta..r.v.y*, *eas̀*, *eab′*, *rab′.v.e*, *kva*, *tva.y.r*, *ueva.rs*, *esvya*, *etra.b′o′*, *etrdkva*, *etdksvab*. Twins. 1. Twin-face *u*. 2. Twin-face *r*. 3. Twin-face *o*. Cleavage. *r*, tolerably perfect. Fracture conchoidal. Translucent on the edges. Opaque. Lustre adamantine, inclining to metallic. Carmine-red...blackish lead-grey. Acquires a tarnish. Streak cochineal-red...cherry-red. Slightly sectile. H = 2·0...2·5. G = 5·75...5·85.

Decrepitates when heated. In the open tube yields sulphurous acid and fumes of antimony, and sometimes a crystalline sublimate of oxide of antimony. Melts easily before the blowpipe on charcoal with disengagement of sulphurous acid and vapour of antimony, leaving a globule of silver. Partially soluble in nitric acid, leaving a residue of sulphur and oxide of antimony. Caustic potash dissolves out sulphide of antimony.

$\acute{A}g^3\overset{\prime\prime\prime}{S}b$, silver 58·98, antimony 23·46, sulphur 17·56.

Analyses of Pyrargyrite *a* from Andreasberg by Bonsdorff, *b* from Mexico by Wöhler, *c* from Zacatecas by Böttger :—

	a	*b*	*c*
Silver	59·13	60·2	57·45
Antimony . .	22·92	21·8	24·59
Sulphur . . .	16·69	18·0	17·76

In attached crystals, massive and disseminated, in veins with calcite, galena, and various ores of silver.

Occurs, as well as the following species, which is much less abundant, in veins in crystalline slate and transition rocks, granite, trachyte, with arsenic, silver, argentite stephanite, galena, blende, quartz, calcite, chalybite, baryte, fluor, &c. Is found at Andreasberg in the Harz, Freiberg in Saxony, Joachimsthal, Altwoschitz and Ratiborzitz in Bohemia, Wolfach in Baden, Schemnitz and Kremnitz in Hungary, Guanaxuato and Zacatecas in Mexico, Callington in Cornwall.

According to Breithaupt, the angle rr' = 71° 20′. In a crystal of pyrargyrite from Mr. Brooke's collection, the observed angles between every two of the three faces r, r', r'' were 71° 18′, 71° 17′·5, 71° 18′·5. In another crystal, not quite so good as the former, the observed angles were 71° 16′·5, 71° 16′·5, 71° 16′.

In addition to the simple forms already enumerated, Levy gives $\bar{1}22$, $32\bar{1}$, $12\bar{1}$ as belonging either to pyrargyrite or to proustite.

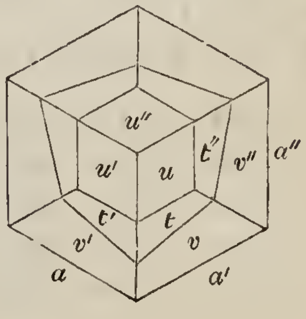
100. PROUSTITE.—Red silver (in part) ; Phillips. Proustite ; Beudant. Rubinblende ; Hausmann. Proustit ; Haidinger.

Rhombohedral. 100,111 = 42° 51′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *u* 211, *e* 011, *r* 100, *s* $\bar{1}11$, *h* $\bar{4}55$, *t* 310, *v* $20\bar{1}$, *y* $30\bar{2}$.

bo	90°	0′	hh'	89°	23′	va	72°	21′
ao	90	0	ss'	99	20	va''	52	41
ba'	30	0	vo	67	50	va'	24	35
bb''	60	0	yo	76	7			
aa'	60	0	to	31	32			
uo	13	3	xo	78	29			
ro	42	51	tr	16	4			
eo	24	53	re''	36	5			
ho	54	18	vr	29	20			
so	61	41	yr	37	59			
uu'	22	34	rs''	49	40			
rr'	72	10	xa'	15	48			
ee'	42	44	vs''	37	19			

FIG. 219.



Combinations generally the same as those of pyrargyrite. The following, however, are said to be peculiar to proustite:—*vs*, *va.s.t.u*, *vaut*, *ey.a.r*, *ohv*, *evx*. Cleavage. *r*, tolerably distinct; *e*, traces. Fracture conchoidal...uneven. Semi-transparent...translucent on the edges. Lustre adamantine. Cochineal-red...carmine-red. Streak aurora-red...cochineal-red. Slightly sectile. H = 2·0...2·5. G = 5·5...5·6.

Decrepitates when heated. Melts easily before the blowpipe on charcoal, yielding sulphurous acid and a strong smell of arsenic, and leaves a brittle globule reducible with difficulty to pure silver. Partially soluble in nitric acid, leaving a residue of sulphur and arsenious acid. Caustic potash dissolves out sulphide of arsenic.

$\overset{\prime}{A}g^3\overset{\prime\prime\prime}{A}s$, silver 65·38, arsenic 15·16, sulphur 19·46.

Analysis of proustite from Joachimsthal by H. Rose:—

Silver	64·67
Arsenic	15·09
Antimony	0·69
Sulphur	19·51

Occurs in attached crystals, botryoidal, massive, disseminated and investing other minerals, in veins with arsenic, ores of silver.

Is found at Schneeberg, Johann-Georgenstadt, Annaberg, Freiberg, Marienberg in Saxony; Joachimsthal in Bohemia, Wolfach in Baden, Markirchen in Alsace, Chalanches in Dauphiné, Guadalcanal in Spain, Mexico, Peru.

The angles of proustite given above were deduced from the observed values of the angles between the faces of the form *v*. These make *rr′* = 72° 10′. According to Breithaupt, *rr′* = 72° 11′.

101. MIARGYRITE. — Miargyrite; Beudant. Hemiprismatische Rubin-Blende; Mohs. Miargyrit; Hausmann, Haidinger.

Oblique. 101,100=40° 2′; 111,010=26° 38′; 101,001=41° 34′.

a 100, *b* 010, *c* 001, *w* 011, *i* 101, *n* 301, *o* $\bar{1}01$, *m* 110, *v* 310, *t* 111, *s* 211, *d* 311, *f* 511, *e* 212, *r* 112, *h* 113, *l* 114, *q* 116, *ζ* 1 1 10, *x* $\bar{2}21$, *y* $\bar{1}12$, *g* $\bar{3}13$, *p* $\bar{6}16$, *k* 421, *z* 731.

na	17°	38′	*oa′*	48°	14′	*vv′*	90°	30′
ia	40	2	*wc*	70	51	*ma*	70	11
ca	81	36	*bc*	90	0	*mm′*	39	38
ic	41	34	*ww′*	38	18	*ba*	90	0
oc	50	10	*va*	44	45	*ti*	63	22

tt′	53° 16′		*tc*	70° 24′		*rr′*	75° 38′
ss′	77 13		*mc*	87 20		*xx′*	38 44
dd′	95 59		*cx′*	96 10		*yy′*	69 6
ff′	115 54		*cy′*	119 47		*zv*	8 8
gg′	106 21		*kb*	35 34		*kv*	12 49
pp′	141 1		*zb*	38 56		*tv*	29 11
ee′	90 10						
ζc	17 40						
qc	27 34						
lc	37 54						
hc	45 43						
rc	56 21						

FIG. 220.

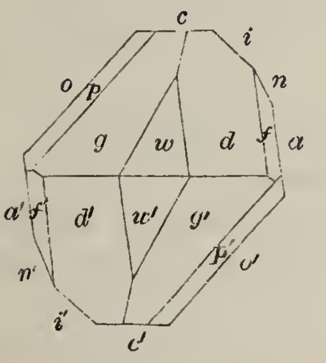
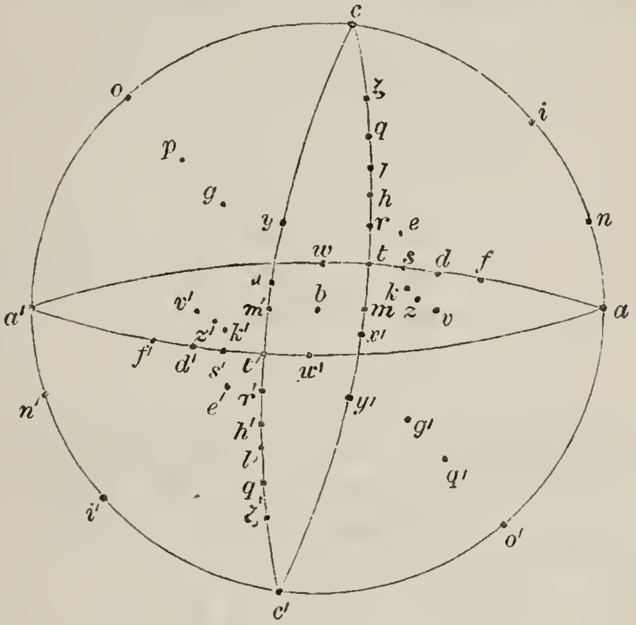


FIG. 221.



Combinations. *cov, codfa, ceosdfab, ciogpdnwa.s.f, acioxgvztrhlqζ, bxmtryzkvd.* The faces *g, o, p* striated parallel to their intersections with each other; *i, n* striated parallel to their intersections with each other. Cleavage. *i, a* imperfect. Fracture imperfect conchoidal. Opaque. Lustre adamantine, inclining to metallic. Blackish lead-grey, inclining to iron-black and steel-grey. In thin splinters blood-red by transmitted light. Streak cherry-red. Very sectile. H = 2·5. G = 5·3...5·4.

In the open tube melts easily, yields sulphurous acid and a sublimate of oxide of antimony. Before the blowpipe on charcoal with soda yields a globule of silver. Partially soluble in nitric acid, leaving a residuum of sulphur and oxide of antimony. Caustic potash dissolves out the sulphide of antimony.

$\overset{\prime}{\mathrm{Ag}}\overset{\prime\prime\prime}{\mathrm{Sb}}$, silver 35·86, antimony 42·79, sulphur 21·35.

Analysis of miargyrite from Bräunsdorf by H. Rose:—

Silver	36·40
Copper	1·06
Iron	0·62
Antimony	39·14
Sulphur	21·95

Is found in attached crystals, massive and disseminated, at Bräunsdorf near Freiberg in Saxony.

The forms *t*, *r*, *h*, *l*, *q*, *ζ*, *x*, *y*, *k*, *z* were observed in crystals in Mr. Brooke's collection.

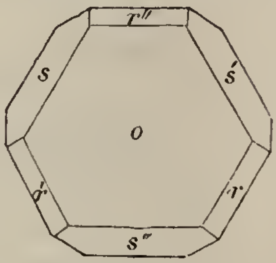
102. XANTHOCONE.—Xanthokon; Hausmann, Haidinger.

Rhombohedral. 100,111 = 69° 30′.

o 111, *r* 100, *s* $\bar{1}$11.

ro	69°	30′
rr′	108	26
so	79	25
sr′	58	21
ss′	116	42

FIG. 222.



Combination. *ors.* Cleavage. *o*, *r*. Fracture conchoidal, uneven. Transparent…translucent. Lustre adamantine. Orange-yellow…brown. Streak the same, but darker. Brittle. H = 2·0…3·0. G = 5·158…5·191.

In the matrass melts at a heat below redness, becomes lead-grey, and yields a slight sublimate of sulphuret of arsenic. In the open tube evolves sulphurous and arsenious acids. Before the blowpipe emits fumes of sulphur and arsenic. The remainder fused with soda yields a globule of silver.

$\overset{\prime}{A}g^3\overset{\prime\prime\prime\prime\prime}{A}s + 2\overset{\prime}{A}g^3\overset{\prime\prime\prime}{A}s$, silver 64·07, arsenic 14·82, sulphur 21·11.

Analyses by Plattner:—

Silver . . .	64·18	63·88
Iron	0·97	—
Arsenic . . .	13·49	14·32
Sulphur . . .	21·36	21·80

Is found in crystals of extreme thinness in the direction perpendicular to the faces *o*, and in small reniform aggregations, in the Himmelsfürst mine near Freiberg in Saxony.

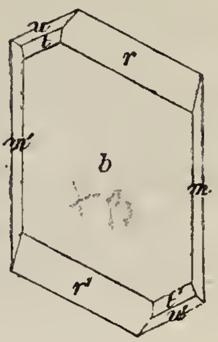
103. FEUERBLENDE.—Feuerblende; Mohs, Haidinger.

Oblique. 101,100=62° 35′; 111,010=50° 34′; 101,001=53° 51′.

a 100 twin-face, *b* 010, *t* 011, *u* 012, *m* 110. *a* truncates the edge formed by *m* and the plane parallel to *m′*.

tb	37° 0′		*rm*	58° 24′	
ub	56 26		*rt*	30 54	
mb	69 36		*rba*	74 57	
ab	90 0		*tba*	116 26	
rb	31 18				

FIG. 223.



The faces *b* are striated parallel to their intersections with *t*. Twins. Twin-face *a*. Translucent. Lustre pearly, inclining to adamantine. Sectile and rather flexible. H = 2·0. G = 4·2...4·3.

Its reactions before the blowpipe are the same as those of pyrargyrite.

Contains silver 62·3 per cent., with antimony and sulphur.

In delicate attached crystals.

Is found in the Kurprinz near Freiberg and at Andreasberg.

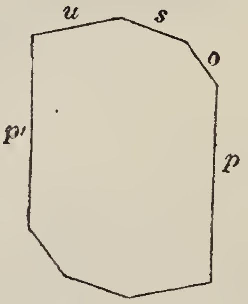
104. KERMES.—Red antimony; Phillips. Antimoine oxidé sulphuré; Hauy. Prismatische Purpur-Blende; Mohs. Antimonblende; Hausmann. Kermes; Haidinger.

Oblique.

p 100, *u* 001, *o* 101, *s* 103.

op	37° 45′
sp	72 6
up	102 9

FIG. 224.



Cleavage. *p*. The crystals are elongated in the direction of the axis of the zone *pou*. Faintly translucent. Lustre adamantine, inclining to metallic. Cherry-red. Streak the same. Sectile. In thin leaves, slightly flexible. H = 1·5. G = 4·5...4·6.

Melts before the blowpipe and emits fumes, depositing a sublimate of oxide of antimony on the charcoal. Soluble in hydrochloric acid with evolution of hydrosulphuric acid. In powder becomes yellow, and is completely dissolved in caustic potash.

$\overset{\cdots}{\mathrm{Sb}}\overset{\prime\prime\prime}{\mathrm{Sb}}{}^2$, antimony 76·34, oxygen 4·73, sulphur 18·93.

Analyses by H. Rose:—

Antimony	74·45	75·66	—
Oxygen	5·29	4·27	—
Sulphur	—	—	20·49

In very fine diverging or interlaced acicular crystals; amorphous, having a radiating columnar or fibrous structure.

Is found in veins in crystalline slate and transition rocks, with quartz and almost always antimonite, at Bräunsdorf near Freiberg in Saxony, Michelsberg and Przibram in Bohemia, Perneck near Malaczka in Hungary, Allemont in Dauphiné.

The angles are given on the authority of Kengott (Mineralogische Untersuchungen, Erstes Heft.).

105. VOLTZINE.—Voltzine; Dufrénoy. Voltzin; Mohs, Hausmann, Haidinger.

In very small hemispheres investing other minerals, having a curved lamellar structure. Fracture conchoidal. Translucent on the edges...opaque. Lustre pearly, on the surface of fracture vitreous, inclining to resinous. Brick-red, inclining to yellow and brown. H = 4·5. G = 3·66.

Before the blowpipe on charcoal deposits a sublimate of oxide of zinc.

$\overset{\prime}{Zn}{}^4\dot{Zn}$, sulphide of zinc 82·73, oxide of zinc 17·27.

Analysis by Fournet:—

Sulphide of zinc	82·92
Oxide of zinc	15·34
Red oxide of iron . . .	1·84

Is found in a vein of quartz, with pyrite, galena, and towanite, at Rosières near Pontgibaud in the department of Puy de Dome in France. According to Kersten a similar compound has been found in the zinc furnaces of Freiberg in Saxony, Altenau in the Harz, and Altenberg near Aix-la-Chapelle.

OXIDES, EARTHS, AND ACIDS.

106. SPARTALITE.—Red oxide of zinc; Phillips. Zinc oxide ferrifère; Hauy. Prismatisches Zink-Erz; Mohs. Zink oxyd; Hausmann. Zinkit; Haidinger.

Rhombohedral. 100,111 = 37° 30′.

a $01\bar{1}$, *r* 100, *x* $51\bar{3}$, *v* $3\bar{1}\bar{1}$.

ao	90°	0′	*vo*	71°	57′	*rr′*	63°	30′
aa′	60	0	*xo*	60	34	*ra′*	58	15
ro	37	30	*xa*	29	26	*va′*	34	34

FIG. 225.

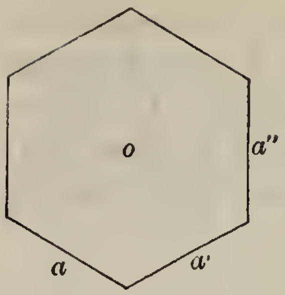


FIG. 226.

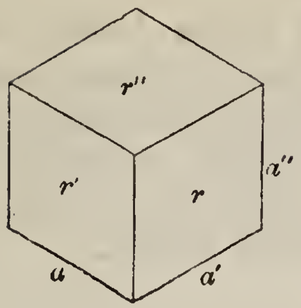
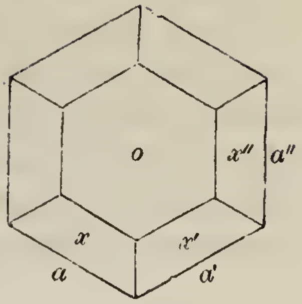


FIG. 227.



Cleavage. *o*, *a* distinct. Fracture conchoidal. Translucent on the edges. Lustre adamantine. When pure colourless, usually red, inclining to yellow. Streak orange-yellow. Brittle. H = 4·0...4·5. G = 5·43...5·53.

Before the blowpipe phosphoresces strongly; is infusible. On charcoal with soda yields a sublimate of zinc. With borax and salt of phosphorus yields the reaction of manganese. Soluble without effervescence in nitric acid. When exposed to the air becomes dull and coated with a white crust.

$\dot{\mathrm{Zn}}$, zinc 80·26, oxygen 19·74.

Analyses *a* of granular spartalite disseminated in franklinite from New Jersey, *b* of cleavable spartalite associated with magnetite from Sterling, both by Whitney; *c* by Hayes:—

	a		*b*		*c*
Oxide of zinc	94·45		96·19		93·48
Oxide of manganese .	trace		3·70	$\dot{\mathrm{Mn}}$	5·50
Franklinite	4·49	$\dot{\mathrm{Fe}}\dddot{\bar{\mathrm{Fe}}}$	0·10	$\dddot{\bar{\mathrm{Fe}}}$	0·36
Loss by ignition . .	1·09		—	hematite	0·44

Is found in beds with franklinite and calcite in the Franklin, Sterling and Rutger's iron mines in Sussex county in New Jersey, and near Sparta. It has also been found distinctly crystallized in iron and zinc furnaces.

The form *r* was observed by Descloiseaux in crystals of oxide of zinc formed in cavities in roasted blende; *x* was observed in some artificial crystals obtained from Professor Wöhler, and by Levy in crystals formed by sublimation; *v* was observed by Hausmann and Koch in crystals formed in iron furnaces.

107. MINIUM.—Native minium; Phillips. Plomb oxidé rouge; Hauy. Mennige; Hausmann, Haidinger.

Fracture earthy, even, flat conchoidal. Opaque. Lustre resinous, feeble...dull. Aurora-red. Streak orange-yellow. H = 2·0...3·0. G = 4·6.

When slightly heated grows darker, resuming its bright red colour on cooling. Before the blowpipe at a red heat becomes yellow, melts very easily, and is reduced on charcoal. In hydrochloric acid is converted into colourless chloride of lead with evolution of chlorine. Partially soluble in nitric acid, leaving a residue of brown peroxide of lead.

$\dot{Pb}^2\ddot{Pb}$, lead 90·66, oxygen 9·34.

Occurs massive, disseminated and pseudomorphous after galena and cerussite.

Is found in Anglesea in veins in clay slate with galena, towanite, cerussite, anglesite; at Grassington Moor in Craven, and at Grasshill Chapel in Weirdale in Yorkshire; at Hausbaden near Baden Weiler with galena, cerussite and quartz; at Bleialf in the Eiffel and Schlangenberg in Siberia.

108. PLATTNERITE.

— Schwerbleierz; Mohs. Braunbleioxyd; Hausmann. Plattnerit; Haidinger.

Rhombohedral.

o 111, *a* $01\bar{1}$, *x* 120.

ao	90°	0′	
aa′	60	0	(fig. 227.)

Combination. *oax.* Fracture uneven. Opaque. Lustre adamantine, inclining to metallic. Iron-black; acquires a tarnish and becomes dull. Streak brown. Brittle. G = 9·392 ...9·448.

Is easily reduced before the blowpipe on charcoal.

$\ddot{Pb}$, lead 86·62, oxygen 13·38, according to Plattner and Lampadius.

Is supposed to have been found at Leadhills.

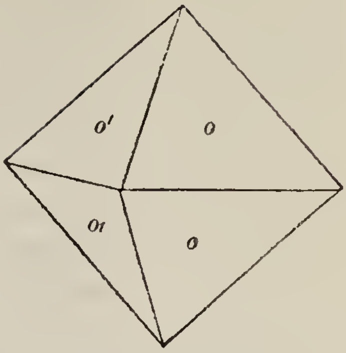
109. PECHURAN.

—Pitch-blende; Phillips. Péchurane; Hauy. Untheilbares Uran-Erz; Mohs. Pechuran; Hausmann. Uranine; Haidinger.

Cubic.

o 111.

FIG. 228.



oo′ 70° 32′

Fracture conchoidal...uneven. Opaque. Lustre resinous. Pitch-black, greenish-black, greyish-black. Streak greenish-black. Brittle. H = 5·5. G = 6·4...6·71.

Infusible before the blowpipe. With borax and salt of phosphorus yields a yellow globule in the outer flame, and a green globule in the inner flame. Dissolves in hot nitric acid, forming a yellow solution.

$\dot{\mathrm{U}}\dddot{\mathrm{Ʉ}}$, uranium 84·78, oxygen 15·22, with from 20 to 24 per cent. of lead, bismuth, iron, arsenic, lime, magnesia, silica, water, and sometimes selenium and vanadium.

Analyses of pechuran from Joachimsthal *a* by Rammelsberg, *b* by Ebelmen, *c* by Scheerer:—

	a		*b*		*c*
Oxide of uranium $\bar{\mathrm{U}}\bar{\mathrm{Ʉ}}$ . .	79·15		75·94		76·6
Lead	6·20		4·22		—
Bismuth with Pb and Cu .	0·65	$\dot{\mathrm{M}}\mathrm{n}$	0·82		1·0
Iron	3·03	$\dot{\mathrm{F}}\mathrm{e}$	3·10		—
Arsenic	1·13	S	0·60		—
Lime	2·81		5·24	oxide of lead	—
Magnesia	0·46		2·07	metallic acids	15·6
Silica	5·30		3·48	silica	—
Water	0·36		1·85		4·10
		$\dot{\mathrm{N}}\mathrm{a}$	0·25	stony matter	2·7
		$\bar{\mathrm{C}}$	3·32	and loss	

Is found at Johann-Georgenstadt, Weisenthal, Marienberg, Annaberg and Schneeberg in Saxony; at Joachimsthal and Przibram in Bohemia, associated with torberite, and in the tin mines of Tincroft and Tolcarn near Redruth in Cornwall.

110. CORACITE.—Le Conte. Silliman's Journal. 1847. 3. 173.

Amorphous. Fracture uneven. Pitch-black. Streak grey. H = 3·0. G = 4·378.

Unchanged before the blowpipe. With the fluxes gives the characteristic reactions of uranium. Readily soluble with effervescence in hydrochloric acid. The solution has a green colour.

Analysis by Whitney :—

Oxide of uranium $\ddot{\bar{U}}$	59·30
Oxide of lead	5·36
Oxide of iron	2·24
Alumina	0·90
Lime	14·44
Carbonic acid	7·47
Water	4·64
Silica	4·35

Is found on the north shore of Lake Superior.

111. WOLFRAMOCHER.—Oxide of tungsten; Phillips. Wolframocher; Hausmann, Haidinger.

Earthy. Opaque. Dull. Yellow.

Before the blowpipe on charcoal in the inner flame at first becomes blackish-blue, and then black. With salt of phosphorus in the outer flame forms a colourless or yellow glass, and in the inner flame a glass which becomes blue on cooling. Completely soluble in alkalies, especially in ammonia.

$\dddot{W}$, scheelium 79·84, oxygen 20·16.

Occurs massive investing other minerals. Is found at Huntington in the United States with wolfram and scheelite.

112. MOLYBDÄNOCHER. — Oxide of molybdenum; Phillips. Acide molybdique; Beudant. Molybdänocher; Hausmann, Haidinger.

Earthy. Opaque. Dull. Orange-yellow...straw-yellow... siskin-green.

Fusible before the blowpipe. With salt of phosphorus in the inner flame forms a glass which is dark while hot, but which becomes green and transparent on cooling. Reducible with soda. Soluble in hydrochloric acid, in potash, and in ammonia.

$\dddot{Mo}$, molybdenum 66·52, oxygen 33·48.

Occurs massive and disseminated.

Is found with molybenite in Sweden, at Linnas in Smaland, Bispberg in Dalarne, at Nummeladen in Norway, at Corybuy in Loch Creran in Scotland, Pfälzerthal in the Tyrol.

113. WISMUTHOCHER.—Bismuth ochre; Phillips. Bismuth oxidé; Hauy. Wismuthocker; Mohs, Hausmann, Haidinger.

Fracture uneven...earthy. Opaque. Lustre adamantine, feeble. Yellow...grey. Soft, friable. G = 4·361.

Before the blowpipe on charcoal is easily reduced. Soluble in nitric acid.

$\overset{\cdots}{\mathrm{Bi}}$, bismuth 89·87, oxygen 10·13.

Analysis by Lampadius :—

Oxide of bismuth	86·3
Red oxide of iron	5·2
Carbonic acid	4·1
Water	3·4

Occurs massive and disseminated.

Is found with bismuth in Saxony, Bohemia, Siberia.

114. CUPRITE.—Red oxide of copper; Phillips. Cuivre oxidulé; Hauy. Oktaedrisches Kupfer-Erz; Mohs. Kupferroth; Hausmann. Cuprit; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *e* 210, *y* 510, *p* 122, *q* 133, *n* 211, *s* 321.

aa′	90°	0′	*ea*	26°	34′	*na*	35°	16′
oa	54	44	*ya*	11	19	*no*	19	28
oo′	70	32	*po*	15	48	*sa*	36	42
da′	45	0	*pd*	19	28	*so*	22	13
do	35	16	*qo*	22	0			

FIG. 229.

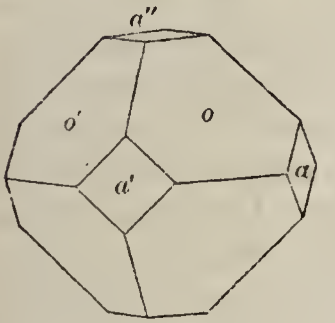


FIG. 230.

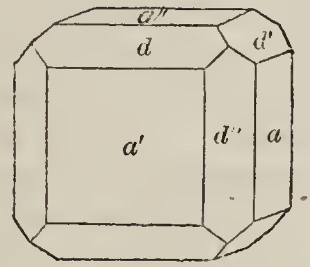


FIG. 231.

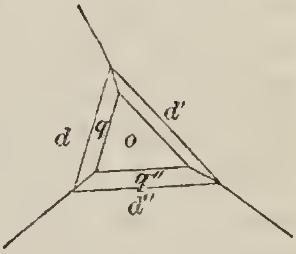


FIG. 232.

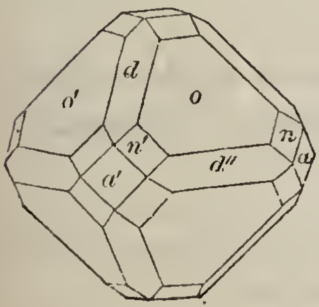


FIG. 233.

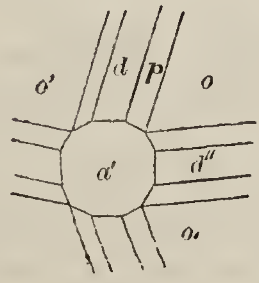
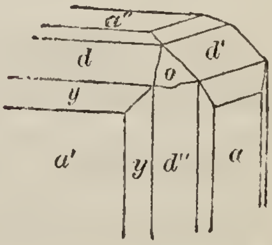


FIG. 234.



Forms and combinations. *a*, *o*, *d*, *ao*, *ad*, *od*, *aod*, *odq*, *aodp*, *aodn*, *aodepns*. Cleavage. *o*, surfaces of cleavage smooth, but interrupted. Fracture conchoidal...uneven. Surface smooth and splendent. Semi-transparent...translucent on the edges. Lustre adamantine, inclining to metallic. Cochineal-red...lead-grey. Streak brownish-red, shining. Brittle. H = 3·5...4·0. G = 5·89...6·15.

Before the blowpipe in the forceps colours the flame green, moistened with hydrochloric acid colours the flame blue; on charcoal in the inner flame is reduced. Soluble in nitric acid with effervescence, in hydrochloric acid without effervescence, and in ammonia.

$\dot{\bar{\mathrm{C}}}\mathrm{u}$, copper 88·79, oxygen 11·21.

Analyses by Klaproth and Chenevix:—

Copper	91	88·5
Oxygen	9	11·5

In attached and imbedded crystals, and granular or earthy masses.

Occurs in beds and veins, especially in granite and in crystalline slate rocks, accompanied by copper, redruthite, towanite, bornite, malachite, chessylite, galena, blende, pyrite, göthite. Is found in beds in gneiss at Moldawa in the Banat, in beds in sandstone at Katherinenburg in Siberia and at Chessy near Lyons, in veins of tin and copper ore in Cornwall; in the island of Cuba, at Linares in Spain, in Saxony, near Siegen, Norway, Australia, Peru, Chile.

The fibrous variety has been supposed to be rhombohedral, and therefore to constitute a distinct species. Mr. Brooke has in his cabinet a series of specimens of this mineral from Cornwall and from Siberia, passing from moderately large and slightly elongated cubic crystals to very slender fibres, which still retain the square form. We have also examined the fibrous specimens in the collection of the late Sir Abraham Hume, now in the Museum at Cambridge, and find these also to be slender elongated four-sided fibres. It appears probable, therefore, that there has been some mistake in supposing all the fibrous varieties to be rhombohedral.

115. RUTILE.—Rutile; Phillips. Titane oxidé; Hauy. Peritomes Titan-Erz; Mohs. Rutil; Hausmann, Haidinger.

Pyramidal. 101,001 = 32° 47′·3.

a 100, *c* 001, *e* 101, *m* 110, *r* 320, *h* 210, *l* 310, *x* 410, *u* 710, *s* 111, *z* 321, *t* 313, *v* 301 twin-plane.

ua	8°	8′
xa	14	2
la	18	26
ha	26	34
ra	33	41
ma	45	0
aa′	90	0
ea	57	13
ca	90	0
ee″	65	35
ee′	45	2
va	27	22
sm	47	40
ss″	84	40
ss′	56	52
sa′	61	34
ta′	79	46
ea′	90	0
zc	66°	42′
zz′	20	46
zz″	60°	46′
tc	34	11

FIG. 235.

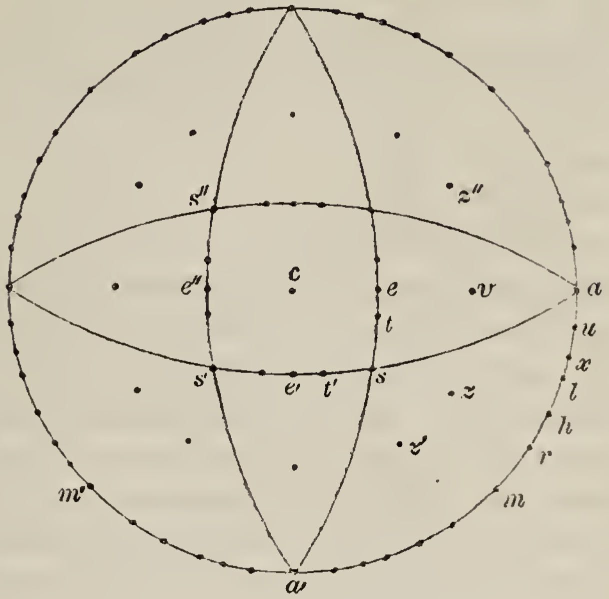


FIG. 236.

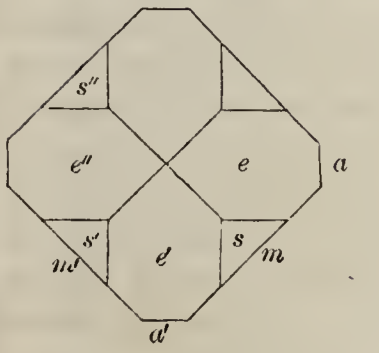


FIG. 237.

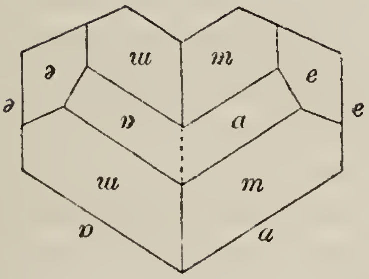
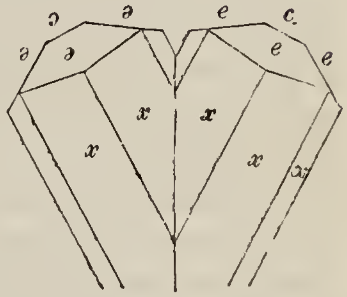


FIG. 238.



Combinations. *sh*, *em*, *shm*, *eam*, *sah*, *esam*, *esamh*, *esamhl*, *esmhlu*, *ezhcr*, *estah*, *estzamh*. Twins. 1. Twin-face *e*. (fig. 237.) The axes of the individuals make with each other angles of 114° 25′ and 65° 35′. 2. Twin-face *v*. (fig. 238.) *ɔc* = 54° 44′. The faces of the zone *ma* are striated parallel to their intersections with each other; *m* sometimes uneven. Cleavage. *a*, *m* tolerably perfect, but interrupted. Fracture conchoidal...uneven. Translucent...opaque. Lustre adamantine, inclining to metallic. Reddish-brown...red, sometimes inclining to yellow, sometimes to black. Streak very light brown. H = 6·0...6·5. G = 4·22...4·30.

Before the blowpipe infusible and unchangeable. With borax yields a greenish glass in the outer flame, and a dirty violet glass in the inner flame; with salt of phosphorus in the inner flame yields a columbine red glass, which on the addition of tin becomes blue or violet. Soluble in bisulphate of potash. In powder with soda melts with intumescence. In very fine powder soluble with difficulty in hot concentrated sulphuric acid. The specific gravity is not altered by ignition.

$\ddot{\mathrm{Ti}}$, titanium 60·13, oxygen 39·87.

Analyses of rutile *a* from St. Yrieux by H. Rose, *b* from St. Yrieux by Damour, *c* from Freiberg by Kersten:—

	a	*b*	*c*
Titanic acid	98·5	97·60	96·75
Red oxide of iron . .	1·5	1·55	2·40

Ekeberg found chrome in rutile from Käring-Bricka in Sweden.

In imbedded and attached crystals and massive, in veins in early rocks with quartz, felspar, mica, tourmaline, or in beds of magnetic iron ore with malacolite and garnet, also disseminated in rocks. Imbedded in quartz at Rosenau in Hungary, on the Bacher in Stiria, at Snarum and Modum in Norway. In implanted crystals in the Saualp and near Windisch-Kappel in Karinthia, Schöllkrippen near Aschaffenburg, Teinach in Stiria, Pfitsch and Lisenz in the Tyrol, Salzburg, near Freiberg. Massive at Gängehänsel near Petschau in Bohemia. In beds of iron ore at Arendal in Norway. Acicular crystals enclosed in quartz and net-like aggregations occur principally in Switzerland and Savoy. In pebbles and crystals in alluvium near Jungwoschitz and Malonitz in Bohemia, in the gold washings of Ohlapian in Transylvania, Ceylon, at St. Yrieux in France, Horcajuelo near Vuitrago in the province of Burgos in Spain. In Sweden, Siberia, South and North America. In Scotland at Cairngorm, in quartz and calcite at Craig Cailleach near Killin, in quartz in Ben-gloe. In gneiss in the Isle of Burray, Shetland; in quartz in Fife and Crianlarich in Perthshire.

Crystals of rutile are frequently attached to the hematite of St. Gotthardt in such a manner that the faces *a*, *e* are very nearly parallel respectively to the faces *o*, *r* of the hematite.

The Mineralogical Museum at Cambridge contains several twins, in which the axes of the individuals make with each other an angle of 54° 44′. These were described in the 'Philosophical Magazine' for October, 1840.

116. BROOKITE.—Brookite; Phillips, Beudant. Brookit; Mohs, Hausmann, Haidinger.

Prismatic. 011,010=41°42′·3; 101,001=43° 21′·7; 110,100=49°55′.

a 100, *b* 010, *c* 001, *x* 012, *y* 014, *d* 403, *t* 201, *m* 110, *l* 120, *k* 140, *p* 2 11 0, *g* 4 23 0, *o* 111, *n* 211, *w* 722, *h* 511, *e* 212, *s* 232, *r* 221, *u* 874, *i* 432, *z* 112, *v* 236, *f* 10 3 2, *θ* 14 5 18.

bc	90°	0′	*ea*	50°	31′	*vc*	32°	46′
ca	90	0	*eb*	67	48	*ia*	46	1
ab	90	0	*ec*	47	41	*ib*	51	47
yy′	31	20	*ua*	49	24	*ic*	68	26
xx′	58	36	*ub*	47	25	*ua*	49	24
dd′	103	5	*uc*	69	52	*ub*	47	25
tt′	124	12	*na*	38	31	*uc*	69	51
pb	8	12	*nb*	62	18	*ha*	17	39
gb	8	20	*nc*	65	32	*hb*	76	55
kb	11	53	*fa*	22	31	*hc*	78	22
lb	22	49	*fb*	70	46	*wa*	24	27
mb	40	5	*fc*	78	43	*wb*	72	0
mm′	80	10	*sa*	64	15	*wc*	74	1
oa	57	51	*sb*	39	15	*θa*	54	57
ob	50	47	*sc*	62	37	*θb*	75	54
oc	55	43	*va*	74	39	*θc*	38	35
ra	52	27	*vb*	61	50			
rb	43	36						
rc	71	11						
za	67	37						
zb	63	6						
zc	36	15						

FIG. 240.

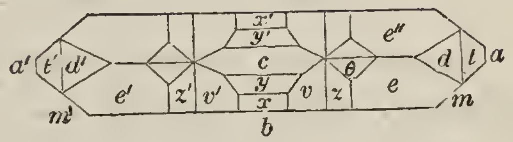


FIG. 239.

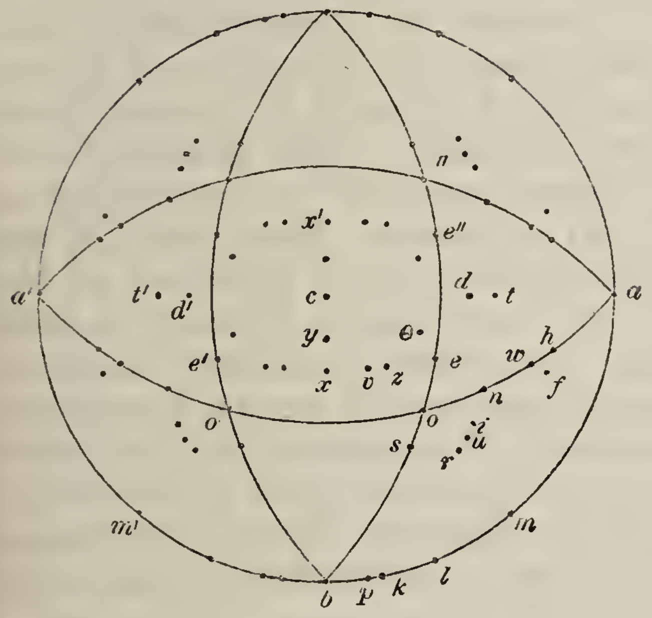


FIG. 241.

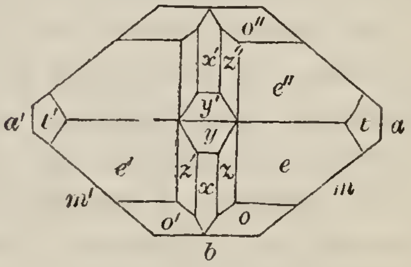
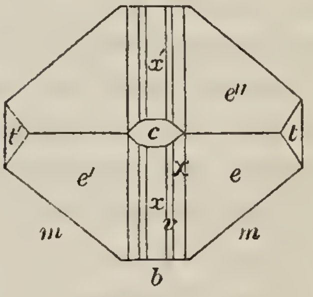


FIG. 242.



Combinations. *bdmeθ, bdmezv, abxdmezv, bcmet..x.z.v, abcxytdmlevθoni, abmxytezo.sf.cnrl, mgxyoe.n, camgze, abcydme, bcxytmenf.* The faces *b* usually striated parallel to their intersections with *m*; *g* striated parallel to their intersections with *m*; *θ* uneven. Cleavage. *a*. Fracture uneven. Translucent....

opaque. Lustre adamantine, inclining to metallic. The optic axes, seen in air through the faces *b*, lie in a plane parallel to *c*, and make angles of 17° 45′ with a normal to *b*. Yellowish-brown, reddish-brown...hyacinth-red. Streak yellowish-white. Brittle. H = 6·0. G =4·125...4·170.

Infusible before the blowpipe. Soluble in salt of phosphorus, to which it imparts a brownish-yellow colour, and in bisulphate of soda. In powder soluble, like rutile, in concentrated sulphuric acid. After ignition over a spirit lamp for three-quarters of an hour, its specific gravity becomes 4·192, very nearly the same as that of rutile.

$\ddot{\mathrm{T}}\mathrm{i}$, titanium 60·13, oxygen 39·87.

Analyses of brookite *a* by H. Rose, *b* from Altän in the Ural (G = 3·81 ?) by Hermann:—

	a	*b*
Titanic acid	89·59	94·09
Red oxide of iron . .	1·41	4·50
Loss by ignition . .	—	1·41

In attached crystals near Bourg d'Oisans in Dauphiné with anatase, albite, quartz and crichtonite, at Tête-Noire near Chamouni in Savoy with quartz, in Steinthal near Amstäg in the Canton of Uri with anatase, adularia, quartz, calcite, in the gold stream-works of Altän between Miask and Slatoust in the Ural, combinations 6...10; Tremadoc in Caernarvonshire with quartz; in extremely minute crystals at Biancavilla on Monte Calvario near Ætna. A variety of brookite in opaque black crystals implanted on quartz (arkansite) from Magnet Cove, Hot Springs County, Arkansas, exhibits the combinations *bcmex..v.z*, differing greatly in appearance from those of the European varieties, in consequence of the smallness of the faces *b*. (fig. 242.) G = 4·085, according to Whitney, a little less than that of brookite from other localities, in consequence probably of a slight intermixture of quartz, from which it was difficult to free it entirely. This is most likely the cause of the low density, G = 3·892...3·949, obtained by Rammelsberg. A qualitative analysis by Whitney showed it to consist of titanic acid with a trace of iron. Rammelsberg found in it at least 94 per cent. of titanic acid.

The forms *k*, *l*, *o*, *i*, *n*, *w*, *h* were first observed by Mr. Brooke in crystals from Snowdon. *r*, *u*, *s*, *f*, *g*, *p* were observed by v. Kokscharow in crystals from the Ural. The faces *θ* are so very uneven that the symbol of the form cannot be determined with certainty; it may be 11 5 14. The symbol of *g* is probably also doubtful.

117. ANATASE. — Anatase; Phillips. Titane anatase; Hauy. Pyramidales Titan-Erz; Mohs. Anatas; Hausmann, Haidinger.

Pyramidal. 101,001 = 60° 38′.

c 001, *e* 101, *q* 201, *u* 105, *m* 110, *p* 111, *z* 113, *r* 115, *v* 117, *s* 5 1 19.

uc	19°	34′
ec	60	38
qc	74	14
vc	19	45
rc	26	41
zc	30	38
pc	68	18
mc	90	0
sc	25	30
pp′	82	9
pe	41	4
uu′	27	24
ee′	63	17
qq′	85	48
pq	42	54
ru	18	31
rr	37	2
vv′	27	39
zz′	42	14
ss′	9	41

FIG. 243.

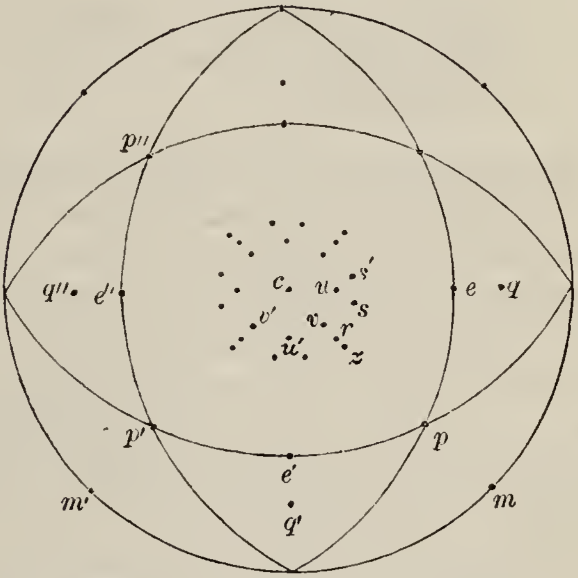


FIG. 244.

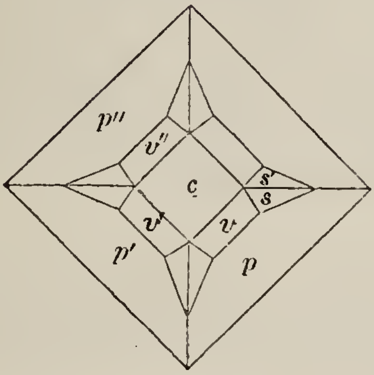
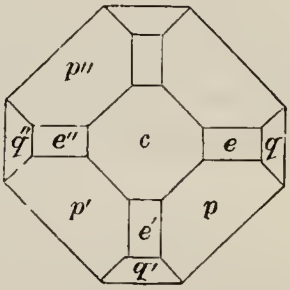


FIG. 245.



Form and combinations. *p*, *cp*, *rp*, *vp*, *sp*, *rpq*, *cvsp*, *cep*, *cepm*, *cepq*, *cvep*, *cvpe*, *crspq*, *cvpeq*. Surface very smooth and bright. The faces *m*, and sometimes *p*, striated parallel to their intersections with each other. Cleavage. *c*, *p* both very perfect. Fracture conchoidal. Semi-transparent...translucent. Lustre adamantine, inclining to metallic. For the brightest part of the solar spectrum $\mu = 2{\cdot}554$, $\mu' = 2{\cdot}493$. Indigo-blue...black, hyacinth-red, honey-yellow...brown, seldom colourless. Streak white. Brittle. H = 5·5...6·0. G = 3·83...3·93. By long continued ignition the specific gravity increases till it becomes equal to that of rutile.

Phosphoresces suddenly when heated before the blowpipe. Infusible. With borax melts into a glass which becomes yellow and at last violet-blue in the inner flame. Soluble with difficulty in salt of phosphorus into a bead which becomes blue in the inner flame. Is not decomposed by acids.

$\ddot{\mathrm{Ti}}$, titanium 60·13, oxygen 39·87.

Analyses of anatase *a* from Bourg d'Oisans, *b* from the Brazils, both by H. Rose; *c* from the Brazils by Damour:—

	a	*b*	*c*
Titanic acid . .	99·25	99·75	98·36
Red oxide of iron .	0·75	0·25	1·11
Oxide of tin . .	—	—	0·20

In attached and imbedded crystals.

Is found in narrow irregular veins in granite and mica slate, associated with quartz, epidote, axinite, felspar, near Bourg d'Oisans in Dauphiné; in mica slate in the valley of Maggia in the Canton of Tessin, and in the valley of Tavetsch in the Grisons, in the Canton of Wallis, in Salzburg, at Lichtenberg and near Hof in the Fichtelgebirge, near Aschaffenburg, in granite in Cornwall and Spain, in many parts of the Ural, in crevices in clay slate near Hof Dale in the parish of Slidre in Norway, in the sand of a brook in which diamonds are found near Itabira de Matto Dentro in Minas Geraes in the Brazils.

Copper-red cubic crystals of $\mathrm{TiCy} + 3\mathrm{Ti}^3\mathrm{N}$, titanium 78·00, nitrogen 18·11, carbon 3·89, are not unfrequently found in the hearths of iron furnaces. When these are ignited in an atmosphere of the vapour of water, they are converted into an aggregation of crystals of anatase.

118. CASSITERITE.—Oxide of tin; Phillips. Etain oxidé; Hauy. Pyramidales Zinn-Erz; Mohs. Zinnstein; Hausmann. Kassiterit; Haidinger.

Pyramidal. 101,001 = 35° 55′·2.

c 001, *a* 100, *e* 101, *w* 501, *m* 110, *h* 210, *r* 320, *s* 111, *y* 335, *i* 552, *t* 313, *z* 321.

ha	26°	34′	*ee′*	46°	29′	*ta′*	79°	28′
ra	33	41	*im*	22	49	*ea′*	90	0
ma	45	0	*sm*	46	26	*zc*	67	35
aa′	90	0	*ym*	60	17	*zz′*	20	54
wa	16	34	*cm*	90	0	*zz″*	61	42
ea	56	5	*ss″*	87	7	*tc*	35	20
ca	90	0	*ss′*	58	20	*zm*	25	0
ee″	67	50	*sa′*	60	51	*em*	66	45

FIG. 246.

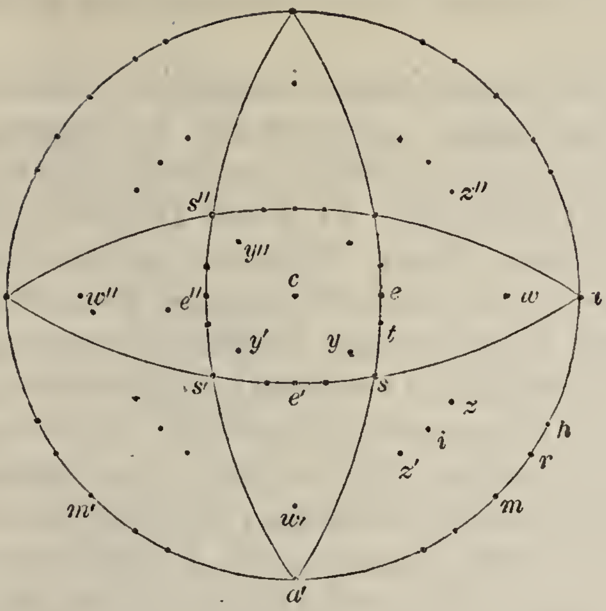


FIG. 247.

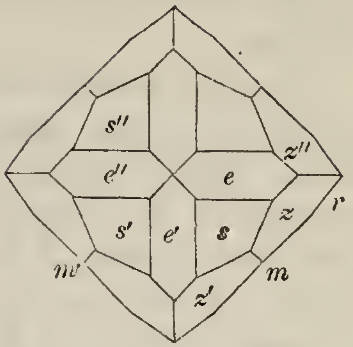
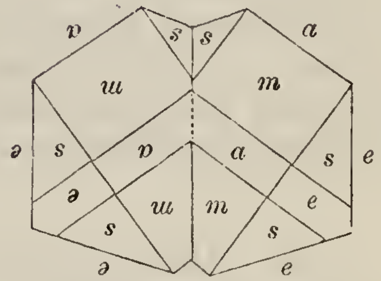


FIG. 248.



Form and combinations. *s*, *sa*, *zh*, *sam*, *szm*, *esam*, *eszm*, *cesam*, *eszmr*, *cesamhr*, *esatmhr*. Twins. Twin-face *e*. The axes of the individuals make with each other angles of 112° 10′ and 67° 50′. The faces *c* rough, *m* often uneven; *s*, *e* sometimes striated parallel to their intersections with each other; *a*, *m*, *r*, *h* sometimes striated parallel to their intersections with each other. Cleavage. *a*, *m* not very distinct; *e*, traces. Fracture imperfect conchoidal...uneven. Semi-transparent...opaque. Lustre adamantine. Colourless, grey, yellow, red, brown, black. Streak light grey, in some varieties light brown. Brittle. H = 6·0...7·0. G = 6·8...7·0.

Before the blowpipe alone unchangeable. On charcoal in the inner flame with soda is reduced to metallic tin. On platinum foil with soda some varieties yield the reaction of manganese. Is not acted upon by acids. Can only be decomposed by fusion with alkalies.

$\ddot{\mathrm{Sn}}$, tin 78·62, oxygen 21·38.

Analyses of cassiterite *a* from Alternon in Cornwall, *b* from Schlackenwald by Klaproth, *c* from Finbo near Fahlun by Berzelius:—

	a	*b*	*c*
Oxide of tin	98·93	99·28	93·6
Red oxide of iron . .	0·32	0·72	1·4
Silica	0·75	—	—
Columbic acid	—	—	2·4
Peroxide of manganese .	—	—	0·8

In attached and imbedded crystals, and in druses, reniform, botryoidal, fibrous and granular masses; pseudomorphous after felspar.

Occurs in veins and beds and disseminated in granite, gneiss, porphyry, mica slate and clay slate, accompanied by quartz, mica, fluor, apatite, topaz, tourmaline, beryl, wolfram, baryte, mispickel, &c., and in alluvial deposits. Is found in Asia, on the east coast of Sumatra, Siam, Pegu, Malacca and in the island of Banca; in Cornwall at St. Just, St. Agnes, Redruth, Penzance, &c.; in Bohemia at Joachimsthal, Platten, Graupen, Zinnwald, Schlackenwald, Schönfeld, Abertham; in Saxony at Altenberg, Ehrenfriedersdorf, Eibenstock, Zinnwald, Breitenbrunn, Johann-Georgenstadt, Geyer, Marienberg; in small quantities at Querbach and Giehren in Silesia; in Gallicia in Spain; in France at Vaulry near Limoges, at Pyriac near Nantes, Vilder in Morbihan; in Mexico and Chile in alluvium; in Sweden at Broddbo; in Russia; in North and South America.

119. BRAUNITE.—Braunite; Beudant. Brachytypes Mangan-Erz; Mohs. Hartbraunstein; Hausmann. Braunit; Haidinger.

Pyramidal. 101,001 = 54° 19′·5.

c 001, *e* 101, *s* 201, *x* 311.

ec	54°	20′
sc	70	15
ee″	108	39
ee′	70	7
ss″	140	30
ss′	83	27
xc	77	13
xx″	35	56
xx′	51	43

FIG. 249.

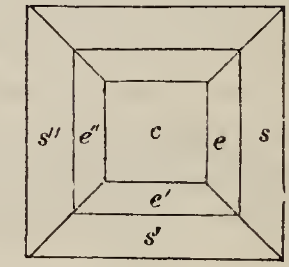
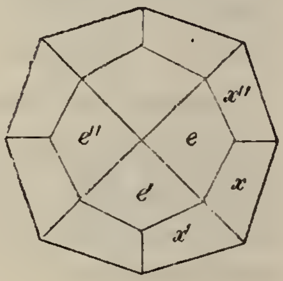


FIG. 250.



Combinations. *ce*, *cs*, *ex*, *ces*. The faces *c* less bright than *e*, and sometimes faintly striated parallel to their intersections with *e*; *e* sometimes slightly convex; *s* uneven and striated parallel to their intersections with *e*; *x* smooth and even. Cleavage. *e*, perfect. Fracture uneven. Opaque. Lustre metallic, imperfect. Dark brownish-black. Streak brownish-black. Brittle. H = 6·0...6·5. G = 4·8...4·9. Conducts electricity.

Infusible before the blowpipe. Imparts a violet colour to borax and salt of phosphorus in the outer flame, which disappears in the inner flame, especially after the addition of tin.

In powder soluble in hydrochloric acid with evolution of chlorine.

$\dddot{\text{Mn}}$, manganese 69·66, oxygen 30·34.

Analyses of braunite *a* from Eglersburg by Turner, *b* from Botnedalen in Oevre-Tellemarken by Tönsager:—

	a		*b*
Manganese	67·44	$\dddot{\text{Mn}}$	89·64
Oxygen	29·35	$\dddot{\text{F}}$	1·57
Barytes	2·62	silica	6·45
Water	0·95		2·06

In small attached and imbedded crystals, and granular masses. Is found in veins in quartzose porphyry with other ores of manganese and baryte at Oehrenstock, Eglersburg and Friedrichrode in Thuringia, at Schmalkalde and Leimbach in Mannsfeld, and Streitberg near Neuenkirchen in Westphalia, with amphibole at St. Marcel in Piedmont.

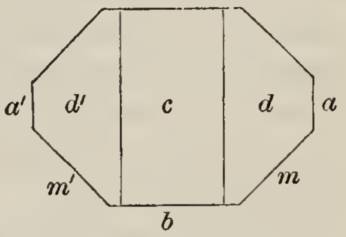
120. PYROLUSITE. — Pyrolusite; Dufrénoy. Prismatisches Mangan-Erz; Mohs. Weichbraunstein; Hausmann. Pyrolusit; Haidinger.

Prismatic. 011,010 = 68° 47′; 101,001 = 20° 0′; 110,100 = 46° 50′.

a 100, *b* 010, *c* 001, *d* 101, *m* 110.

bc	90°	0′
dc	20	0
ac	90	0
ma	46	50
ba	90	0
mm′	86	20

FIG. 251.



c smooth, frequently rather uneven; *a*, *b*, *m* striated parallel to their intersections with each other. Cleavage. *m*, *a*, *b* distinct. Fracture uneven. Opaque. Dark steel-grey...light iron-black. Streak black. Brittle. H = 2·0...2·5. G = 4·7... 5·0. Is a good conductor of electricity.

Infusible before the blowpipe. On charcoal in a strong heat becomes reddish-brown. In the outer flame imparts a violet colour to borax and salt of phosphorus, which disappears in the inner flame. Soluble in hydrochloric acid with abundant evolution of chlorine.

$\ddot{\text{Mn}}$, manganese 63·27, oxygen 36·73.

Analyses of pyrolusite *a* from Undenaes by Arfvedson, *b* from Eglersburg, *c* from an unknown locality, both by Turner, *d* from Ilmenau by Scheffler:—

	a	*b*	*c*	*d*
Red oxide of manganese $\dot{\mathrm{Mn}}\bar{\mathrm{Mn}}$	83·56	84·06	85·62	87·0
Oxygen	14·58	11·78	11·60	11·6
Barytes	—	0·53	0·67	1·2
Lime	—	—	—	0·3
Alumina	—	—	—	0·3
Red oxide of iron	—	—	—	1·3
Silica	—	0·51	0·55	0·8
Water	1·86	1·12	1·57	5·8

In attached crystals, reniform and botryoidal masses, compact, earthy, pseudomorphous after calcite, manganite and polianite, in veins in porphyry, gneiss and other rocks, in beds with psilomelane, hematite, göthite, baryte, chalybite, calcite, aragonite.

Is found at Ilmenau, Friedrichsrode, Eglersburg, Reinweg in Thuringia, Vorderehrensdorf near Mährish-Trübau in Moravia, in the Harz, near Zellerfeld and Goslar, and occasionally at Ihlefeld, pseudomorphous after manganite and calcite; at Johann-Georgenstadt in Saxony, Hirschberg in Westphalia, the Sudelzeche near Platten, and many veins of iron ore in the mining districts of Bohemia; in beds of chalybite, especially when decomposed, in Stiria, Carinthia and Hessia; in veins of chalybite and hydrous iron-oxide in Sayn, Streitberg, Horhausen and Herdorf near Siegen, and near Friedewald, Knorrenberg, Hamm in Westphalia, Schnarchenreuth and Hirschberg near Arzberg in Baireuth, Schwarzenthal in the Riesengebirge, Waidhofen on the Thaia in Austria, Konradswaldau and Reinerz in Silesia, Maczkamezö in Transylvania, Villa Ricca in the Brazils.

Varvicite which, according to the analysis of Phillips, consists of manganese 63·3, oxygen 31·7, water 5, is supposed to be a mechanical mixture of pyrolusite and manganite.

121. POLIANITE.—Polianit; Breithaupt, Haidinger.

Prismatic. 011,010 = 57° 43′; 101,001 = 31° 0′; 110,100 = 46° 26′.

bc	90°	0′
dc	31	0
ca	90	0
ma	46	26
ba	90	0

(fig. 251.)

The faces *a*, *m*, *b* are striated parallel to their intersections with each other. Cleavage. *a*. Opaque. Lustre metallic, feeble. Light steel-grey. Streak grey. H = 6·5...7·0. G = 4·838...4·880. Chemical characters the same as those of pyrolusite.

$\ddot{\mathrm{Mn}}$, manganese 63·27, oxygen 36·73.

Analysis of polianite from the Maria Theresia mine near Platten by Plattner:—

Red oxide of manganese $\dot{\mathrm{Mn}}\dddot{\overline{\mathrm{Mn}}}$ . . .	87·27
Oxygen	12·11
Red oxide of iron and alumina . . .	0·17
Water	0·32
Silica	0·13

Is found in the Procopzeche and the Maria Theresia mine near Platten in Bohemia, the Adam Heber mine at Schneeberg, Tannenbaum Stolln near Johann-Georgenstadt, Spitzleute near Schneeberg, Hirsch near Geyer in Saxony, the Eiserne Hardt in Siegen.

According to Haidinger, polianite is pseudomorphous braunite in the form of pyrolusite.

122. CREDNERITE.—Mangankupferoxyd; Hausmann.

Oblique.

Cleavage very perfect parallel to the end faces of an oblique prism; less perfect parallel to the lateral faces. Fracture uneven. Opaque. Lustre metallic on the principal cleavages, less bright on the other cleavages. Iron-black. Streak black, inclining to brown. H = 4·5...5·0. G = 4·89...5·07.

In the matrass exfoliates and loses its lustre. Before the blowpipe with soda on charcoal yields a malleable bead of copper. With borax in the outer flame forms a violet glass; in the inner flame a green glass, which at last becomes red and opaque. In nitric acid the oxide of copper is dissolved, leaving a black residue. Is readily soluble in hydrochloric acid with evolution of chlorine, forming a green solution.

Analysis by Credner:—

Oxide of copper $\dot{\mathrm{Cu}}$	43·85
Oxide of manganese $\dot{\mathrm{Mn}}\dddot{\overline{\mathrm{Mn}}}$ . .	55·73

Is found in cleavable granular masses with pyrolusite and hausmannite at Friedrichrode in Thuringia.

Crednerite is liable to decomposition, in consequence of which the cleavages become more distinct, the colour changes to a blackish-blue, H is reduced to 2·5, and G to 4·71.

123. HEMATITE.—Specular iron; Phillips. Fer oligiste; Hauy. Rhomboedrisches Eisen-Erz; Mohs. Hämatit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 57° 30′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *h* $3\bar{1}\bar{2}$, *m* $3\bar{1}\bar{1}$, *l* $4\bar{1}\bar{1}$, *r* 100, ϕ 611, *d* 411, *u* 211, λ 655, *y* 233, μ 122, *c* 255, γ 133, *e* 011, η $\bar{1}22$, ψ $\bar{4}55$, *s* $\bar{1}11$, *p* $\bar{3}22$, *z* $17\bar{5}$, *x* $16\bar{4}$, *n* $13\bar{1}$, π 021, *q* 231, *k* $02\bar{1}$, *t* 031, *i* $51\bar{1}$, *g* $41\bar{1}$, χ $21\bar{1}$, ξ $13\bar{2}$, β $13\bar{3}$.

aa'	60°	0′	$\lambda\lambda$	9°	42′	ea	90°	0′
bb''	60	0	yy'	19	12	πa	70	23
ba'	30	0	$\mu\mu'$	30	4	ta	61	52
nb	10	54	uu'	36	53	ar'	43	5
ha'	19	6	cc'	36	53	ka	17	19
bo	90	0	$\gamma\gamma'$	41	30	aq'	78	6
mo	80	57	ee'	64	38	ae''	57	41
lo	75	42	$\phi\phi'$	74	40	$a\chi'$	27	47
ro	57	30	rr'	93	50	ξa	17	33
ϕo	44	27	$\psi\psi'$	105	42	ra	90	0
do	38	7	ss'	111	13	ia	73	43
uo	21	25	ll'	114	6	ga	69	56
λo	5	36	mm'	117	34	an'	64	2
yo	11	6	pp'	118	26	χa	53	51
μo	17	26	er'	46	55	as''	34	24
co	21	25	sr'	55	36	βa	12	51
γo	24	9	nn'	51	56	$\chi\chi'$	34	18
eo	38	7	nr'	25	58			
ηo	57	30						
ψo	66	59						
so	72	20						
po	82	44						
ao	90	0						
zo	79	35						
xo	77	33						
no	61	7						
πo	42	11						
qo	24	22						
ko	76	28						
to	46	4						
βo	83	8						
χo	64	17						
ξo	73	42						
go	59	41						
io	58	57						

FIG. 252.

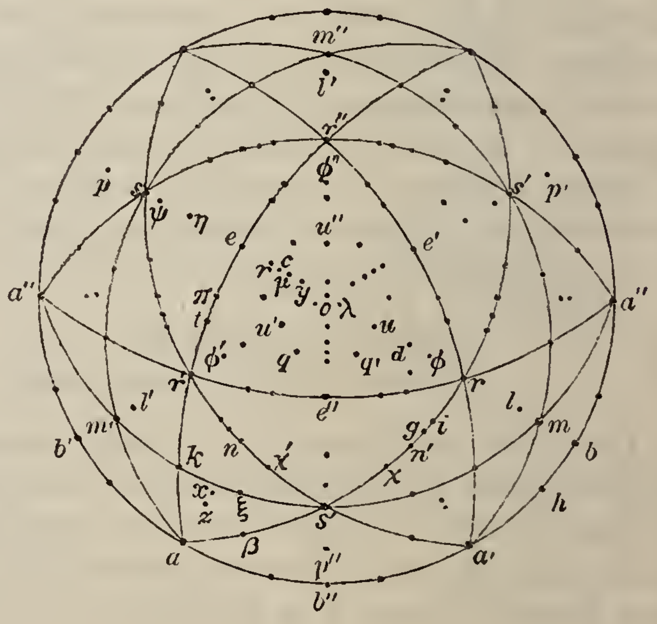


FIG. 253.

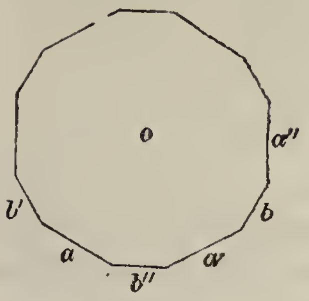


FIG. 254.

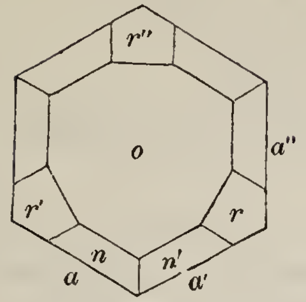


FIG. 255.

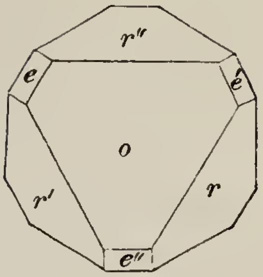


FIG. 256.

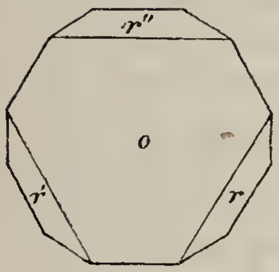


FIG. 257.

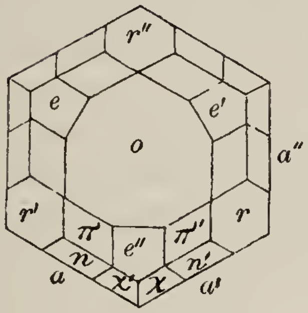
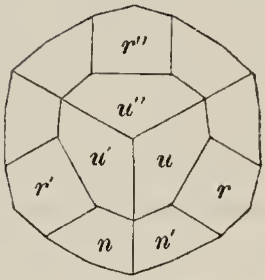


FIG. 258.



Combinations. *or*, *ru*, *rn*, *on*, *rm*, *rbq*, *roe*, *orη*, *ur..n.a*, *orηb*, *orn..γ.a.π*, *ornu..y.μ.yi*, *ornea*, *ornes*, *orntq*, *orntφμ*, *rnyu..i*, *rnyucd*, *orneπχa*, *rneyulsz*, *ornbes..a.u*, *orabesu*, *ornabπu*, *ornbesakβh*. The faces *o* usually smooth and plane, sometimes striated parallel to the intersections with *r*; *r* striated parallel to the intersections with *n*; *y* uneven, frequently curved, striated parallel to the intersections with *u*; *e* sometimes curved, but always smooth; λ, *u*, *b* striated parallel to their intersections with *o*. Twins. 1. Twin-face *o*. 2. Twin-face *r*. Cleavage. *o*, *r* more or less distinct; *e*, traces. *o* is perhaps not a true cleavage, but merely a plane of union. Fracture conchoidal... uneven. Opaque; very thin laminæ are translucent and blood-red by transmitted light. Lustre metallic. $\mu = 3{\cdot}19$, $\mu' = 2{\cdot}82$. Dark steel-grey...iron-black; sometimes iridescent, except *o*. Streak cherry-red...reddish-brown. Brittle. H = 5·5...6·5. G = 5·0...5·3. Sometimes feebly magnetic. Conducts electricity.

Infusible before the blowpipe; in powder becomes black and magnetic. Imparts a yellow colour to borax and salt of phosphorus in the outer flame, and a green colour in the inner flame. Is very slowly soluble in warm hydrochloric acid.

$\overset{\cdots}{\text{Fe}}$, iron 70·00, oxygen 30·00, sometimes with an admixture of titanic acid.

Analyses of hematite from Tavetschthal by v. Kobell:—

Red oxide of iron . . .	94·82
Protoxide of iron	trace
Titanic acid	3·57
Protoxide of manganese .	1·61

In attached crystals; botryoidal, reniform and fibrous masses; scaly, granular and earthy; pseudomorphous after magnetite, pharmacosiderite, fluor, calcite, göthite.

Hematite occurs chiefly in beds and veins in the older rocks, and as an ingredient of some rocks. It is deposited by sublimation in the crevices of active volcanoes, not unfrequently, at the present time; also in pottery furnaces where salt is used for glazing. Is found crystallized in Elba, St. Gotthardt, Caravatti in the Grisons and many other parts of the Alps, Framont in the Vosges, Altenberg and Poberschau in Saxony, Capâo in the Brazils, Thurnberg near Flachau in Salzburg; imbedded in the dolerite of the Meissner, near Hedemünden in the valley of the Werra, St. Just and Tin Croft mines in Cornwall, Cumberhead in Lanarkshire, Schabrowski near Katharinenburg in Siberia. Crystals formed by sublimation are found on Vesuvius, Ætna and Stromboli, Puy de la Vache and Puy de la Chopine in Auvergne, Jumilla in Murcia, in crevices of syenite at Meissen in Saxony, Reps and Magyar-Hermany in Transylvania. It occurs in thin scales (micaceous iron) in the Fichtelgebirge in Bavaria, Reichenau in Bohemia, Gölnitz and Dobschau in Hungary, in mica slate (itacolumite) in many parts of the Brazils, near Tavistock in Devonshire, near Dunkeld in Perthshire, Constantine in Estremadura, Hawley in Massachusetts, Stiria, Carinthia, Moravia, the Harz, Sardinia, Siberia. It occurs massive in beds in Elba, in Sweden at Gellivara in Lulea Lappmark, Norberg, Grengesberg, Langbanshytta; Kalstadt mine near Krageröe in Norway, in the Harz, Salzburg, the Tyrol, Hessia, Westphalia, Saxony, Bohemia, Würtemberg, Lancashire, Cumberland, North America, Asia, Africa. It occurs pseudomorphous after magnetite at Inficionado in Minas Geraes in the Brazils, after calcite at Sundwig near Iserlohn, after göthite at Lostwithiel in Cornwall.

According to Mohs $rr' = 94° 2'$, while according to Phillips $rr' = 93° 50'$, a value agreeing very closely with the measures obtained from a very good crystal, evidently formed by sublimation, and affording the characteristic red streak of hematite. The latter value has consequently been adopted in the present treatise.

When the vapour of chloro-chromic acid, $\mathrm{CrCl^3\bar{C}r^2}$, is transmitted through a red-hot tube, the vapour is decomposed into chlorine, oxygen and oxide of chrome, $\overline{Cr}$, chrome 69·99, oxygen 30·01, which is deposited on the interior of the tube in small twin crystals, the individuals of which resemble the combination *oran* (fig. 254) of hematite, with which, ilmenite and corundum, it is isomorphous, having very nearly the same angles. In these crystals *rr′* = 94° 5′. The twin face is *r*. They have a perfect cleavage parallel to the faces *r*. Lustre metallic, inclining to adamantine. Greenish-black. Streak bright green. H = 9·0. G = 5·21. When a six-sided crystal of hematite was placed in the tube, the oxide of chrome was deposited upon the crystal of hematite with the faces and cleavages of the latter parallel to those of the former, as happens frequently in other cases, when crystals of one of two isomorphous bodies are deposited upon a crystal of the other.

124. ILMENITE.—Fer oxidulé titané; Hauy. Axotomes Eisen-Erz; Mohs. Kibdelophan; Hausmann. Ilmenit, Crichtonit; Haidinger.

Rhombohedral. 100,111 = 57° 30′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *l* $4\bar{1}\bar{1}$, *r* 100, *e* 011, *s* $\bar{1}11$, *ζ* 311, *p* $\bar{3}22$, *n* $13\bar{1}$, *x* $16\bar{4}$. *ζ* truncates the edge *or*. The forms *n*, *x* are frequently hemihedral with parallel faces.

aa′	60°	0′	*eo*	38°	7′	*rr′*	93°	50′
bb′	120	0	*so*	72	20	*ss′*	111	13
ba′	30	0	*po*	84	44	*pp′*	118	26
ab′	30	0	*ao*	90	0	*er′*	46	55
bo	90	0	*xo*	77	33	*sr′*	55	36
lo	75	42	*no*	61	7	*nn′*	51	56
ro	57	30	*ζζ′*	54	50	*nr′*	25	58
ζo	32	7	*ee′*	64	38			

FIG. 259.

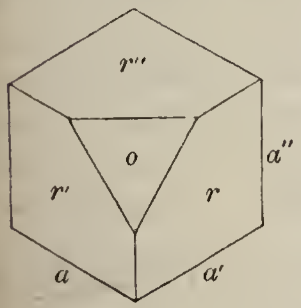


FIG. 260.

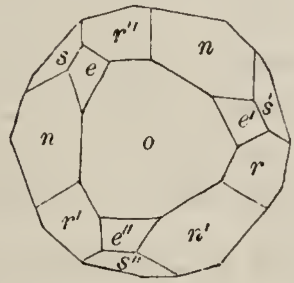
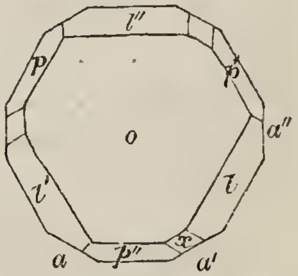


FIG. 261.



Combinations. *or*, *ora*, *ore*, *orn′*, *oers*, *oersn′*, *oζersna*, *op*, *opl*, *opla*, *oplax′*. The faces *o* striated parallel to their intersections with *r*. Twins. Twin-face *o*. Cleavage. *o*, more or less perfect; *r*, indistinct. Fracture conchoidal. Opaque. Lustre metallic, imperfect. Iron-black, sometimes passing into steel-grey. Streak black, in the variety from Spessart and St. Gotthardt brown. Brittle. H = 5·0...6·0. G = 4·66...5·31. More or less magnetic.

Infusible before the blowpipe. With salt of phosphorus in the inner flame forms a red glass. Imparts a blue colour to hot concentrated sulphuric acid without dissolving. In fine powder soluble in concentrated hydrochloric acid. When the solution is concentrated as much as possible without being decomposed, it yields a precipitate of titanic acid on being largely diluted with water and boiled for a considerable time.

Analyses of ilmenite *a* from Gastein, G = 4·665...4·735, by v. Kobell, *b* from St. Christophe near Bourg d'Oisans, G = 4·727 (crichtonite), by Marignac, *c* from the Ilmen mountains, G = 4·76...4·81 (ilmenite), by Mosander, *d* from Egersund, G = 4·751, by H. Rose; *e* from Washington, G = 4·963...5·016 (washingtonite), by Marignac, *f* from Spessart, G = 5·06...5·13, by v. Kobell, *g* from the Binnenthal in Wallis, G = 5·127, by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*
Titanic acid	59·00	52·27	46·92	43·73	22·21	14·16
Red oxide of iron . .	4·25	1·20	10·74	42·70	59·07	75·00
Protoxide of iron . .	36·00	46·53	37·86	13·57	18·72	10·04
Protox. mangan. . .	1·65	—	2·73	—	—	0·80
Magnesia	—	—	1·14	—	—	—

Analyses of ilmenite from the Ilmen mountains *h* by Mosander, *i* by Delesse, *k* from Egersund by v. Kobell, *l* from Connecticut by Kendall, *m* from Udewalla by Plantamour, *n* from St. Gotthardt by v. Kobell:—

	h	*i*	*k*	*l*	*m*	*n*
Titanic acid . . .	46·67	45·4	43·24	25·28	15·56	12·67
Red oxide of iron .	11·71	40·7	28·66	51·84	71·25	82·49
Protoxide of iron .	35·37	14·1	27·21	22·86	11·32	4·84
Protox. mangan. .	2·39	—	—	—	—	—
Lime	0·25	0·5	—	—	—	—
Magnesia . . .	0·60	—	—	—	—	—
Oxide of chrome .	0·38	$\ddot{\mathrm{S}}\mathrm{n}$ 0·5	—	—	—	—
Silica	2·80	$\dot{\mathrm{P}}\mathrm{b}$ 0·2	Fl, $\ddot{\mathrm{S}}\mathrm{i}$, loss		1·87	—

Analyses of ilmenite *o*, *p*, *q* from Arendal, *r*, *s*, *t* from Egersund, all by Mosander:—

	o	*p*	*q*	*r*	*s*	*t*
Titanic acid . .	20·41	24·19	23·59	39·04	42·57	41·08
Red oxide of iron	55·23	53·01	58·51	29·16	23·21	25·93

	o	*p*	*q*	*r*	*s*	*t*
Protoxide of iron	19·48	19·91	13·90	27·23	29·27	29·04
Lime	0·32	0·33	0·86	0·96	0·50	0·49
Magnesia . . .	0·73	0·68	1·10	2·30	1·22	1·94
Oxide of chrome .	—	—	0·44	0·12	0·33	—
Oxide of tin . .	3·64	—	$\dot{\mathrm{Mn}}$	0·21	$\dot{\mathrm{Y}}$, $\ddot{\bar{\mathrm{Ce}}}$	0·58
Silica	0·80	1·17	1·88	0·31	1·65	0·07

It is supposed by H. Rose and Scheerer that the titanic acid ($\ddot{\mathrm{Ti}}$) results from the combination, during the analysis, of the blue oxide of titanium ($\dddot{\bar{\mathrm{Ti}}}$) with part of the oxygen of the red oxide of iron ($\dddot{\bar{\mathrm{Fe}}}$), converting a portion of it into protoxide of iron ($\dot{\mathrm{Fe}}$). According to these views, the true constitution of the different varieties of ilmenite would be as follows:—

	a	*b*	*c*	*i*	*d*	*e*	*m*	*f*	*g*
$\dddot{\bar{\mathrm{Ti}}}$.	53·69	47·04	42·59	40·89	38·25	20·13	14·01	13·39	8·58
$\dddot{\bar{\mathrm{Fe}}}$.	46·31	52·96	57·41	56·37	61·75	79·87	83·83	86·61	81·42

In attached and imbedded crystals, granular and lamellar masses, disseminated and in angular or rounded grains.

It is found with dolomite in talc at Gastein in Salzburg (*orn′*, *oersn′*), Lappach in the Tyrol, in miascite on Lake Ilmen near Miask in the Ural (*ores*, *oresn′*), in Norway at Tvedestrand in garnet (*ora*, *orea*), Friedrichswärn in zircon-syenite, Egersund, Bamle near Krageröe (*oransm*), Arendal in beds of magnetite, Bodenmais in Bavaria, Bourg d'Oisans in Dauphiné (crichtonite, the combinations containing the form *p*) in drusy cavities with quartz, albite, anatase, brookite, Spessart near Aschaffenburg, with rutile at Malonitz near Klattau in Bohemia, St. Gotthardt, in isolated grains in alluvium at Iserwiese in the Riesengebirge, in the gold stream-works at Ohlapian in Transylvania, in the United States at Washington, Lichfield, Westerley and Goshen in Massachusetts, Essex in New York. The combination *oζersna* occurs in crystals from Hamburg in New Jersey, in Mr. Brooke's collection.

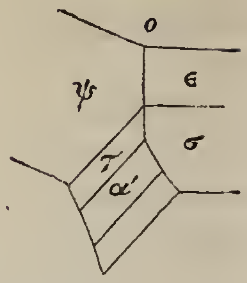
According to Mohs $rr' = 94° 1'$. The values of rr' obtained by Breithaupt for varieties from different localities are as follows:—

Miask	94° 17′	Tavetschthal . .	93° 52·4′
d'Oisans . . .	93 53·5	Tvedestrand . .	93 50

Mohsite is perhaps ilmenite. Rhombohedral. *o* 111, *a* $01\bar{1}$. The value of ψo in mohsite approaches to that of ψo in hematite. If we suppose ψ to be $55\bar{4}$, σ will be $7\bar{2}\bar{2}$, and ε 10 1 1.

oa′	90°	0′	*ψa′*	36°	52′
ψo	67	30	*εε′*	83	38
εo	50	21	*ψψ′*	106	17
σo	78	18	*σσ′*	116	0

FIG. 262.



No cleavage observable. Fracture conchoidal. Opaque. Lustre metallic. Iron-black. Brittle. Scratches glass very easily. Not magnetic. In twin crystals (twin-face *o*) on quartz coloured by chlorite. Is supposed to have been found in Dauphiné.

125. CORUNDUM.—Corundum; Phillips. Corindon; Hauy. Rhomboedrischer Korund; Mohs. Thonerde; Hausmann. Korund; Haidinger.

Rhombohedral. 100,111 = 57° 34′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *f* $5\bar{2}\bar{3}$, *r* 100, *d* 411, *δ* 522, *η* $\bar{1}22$, *s* $\bar{1}11$, *n* $13\bar{1}$, *ς* 3 10 $\bar{4}$, *w* $14\bar{2}$, *κ* $29\bar{5}$, *v* $15\bar{3}$, *z* $17\bar{5}$, *θ* $19\bar{7}$, *ν* 1 13 $\bar{1}\bar{1}$, *ρ* $\bar{3}75$, *g* $41\bar{1}$, *i* $51\bar{1}$.

aa′	60°	0′
bb″	60	0
ba′	30	0
fb	6	35
fa′	23	25
bo	90	0
ro	57	34
do	38	12
δo	27	41
ηo	57	34
so	72	22
ao	90	0
νo	84	45
θo	82	10
zo	79	36
vo	74	36
κo	72	31
wo	69	51
ςo	64	45
no	61	11
qo	59	45

FIG. 263.

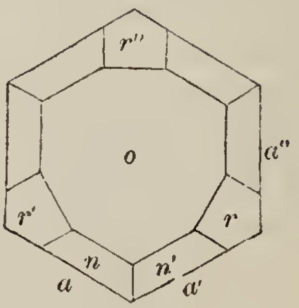


FIG. 264.

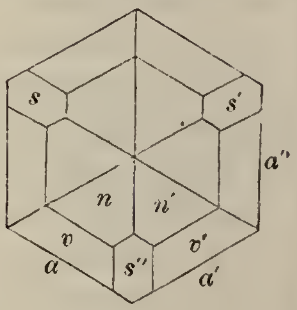


FIG. 265.

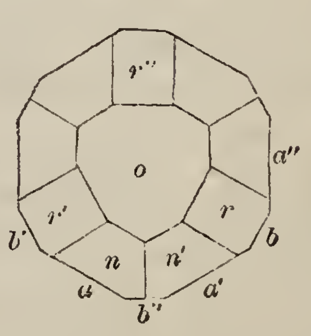
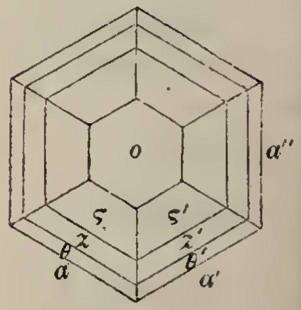
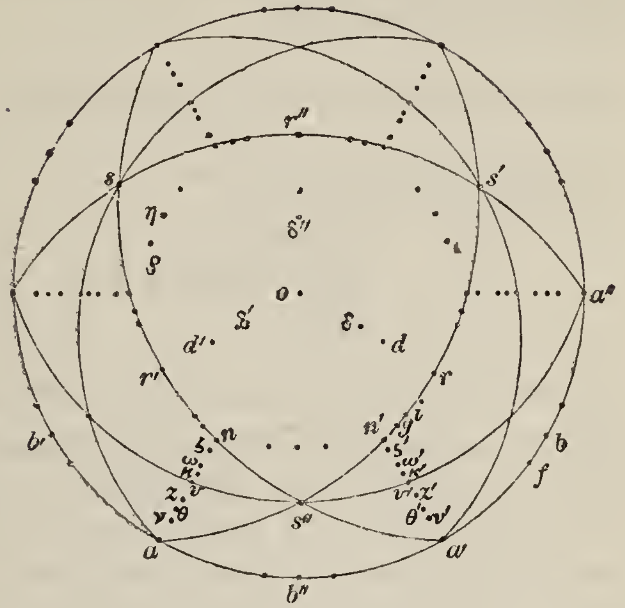


FIG. 266.



io	59°	1′
ρo	58	2
rr′	93	56
δδ′	47	26
ss′	111	15
νν′	59	44
θθ′	59	24
zz′	58	55
vv′	57	38
κκ′	56	58
ww′	56	0
ϛϛ′	53	46
nn′	51	58
ρη	9	14
ra′	43	2
ηr′	49	56
va′	74	37
ra	90	0
ia	73°	42′
ga	69	56
na′	64°	1′
as″	29	22

FIG. 267.



Combinations. *oa, or, ar, rn, zn, ora, orn, orz, onz, orna, ornz, nsva, ornab, obzθa, oarηnρ, oarnϛνgs.* The faces *o* are striated parallel to their intersections with *r*, and sometimes parallel to their intersections with *a*. The faces of the zones *oa* deeply striated parallel to their intersections with each other. Twin crystals. Twin-face *r;* frequently repeated in parallel layers. Cleavage. *r, o,* in many varieties perfect, but interrupted. The planes *r* are frequently merely faces of union. Fracture conchoidal...uneven. Transparent...translucent on the edges. Lustre vitreous; *o* in some varieties pearly. $\mu = 1{\cdot}769$, $\mu' = 1{\cdot}762$. Colourless, white, usually blue or red, also green, yellow, brown, grey. Sometimes different parts of the same crystal have different colours, as blue and red, blue and white, red and white. Some varieties are opalescent, and show a six-rayed star, having its centre in the axis of the crystal, especially when the end is ground convex. By transmitted light some varieties appear green in the direction of the axis, and blue in a direction perpendicular to the axis. On looking through a blue crystal in a direction parallel to *o*, its colour is prussian blue when the light is polarized in a plane perpendicular to *o*, and light green when the light is polarized in a plane parallel to *o*. A red crystal viewed in the same manner is red or very light brown, according as the light is polarized in a plane perpendicular or parallel to *o*. H = 9·0. G = 3·93...4·08.

Infusible before the blowpipe either alone or with soda. Soluble in borax and salt of phosphorus with great difficulty, but perfectly, forming a transparent glass. With solution of cobalt in the outer flame becomes blue. With bisulphate of potash in a platinum capsule over a spirit lamp it melts into a mass which is perfectly soluble in water. Is not acted upon by acids. Fusible into a cleavable mass in the flame of the oxyhydrogen blowpipe.

$\dddot{\mathrm{Al}}$, aluminium 53·19, oxygen 46·81.

Analysis by Klaproth:—

Alumina	98·5
Red oxide of iron . .	1·0
Lime	0·5

In imbedded crystals and in cleavable masses.

The transparent blue and red varieties, called sapphire and ruby respectively, are principally found in gravel and river-sand at Matura and Saffragang in Ceylon, in the Capelan mountains twelve days' journey from Syrian in Pegu, at Hohenstein on the Elbe, Iserwiese and Podsedlitz in Bohemia, Puy in France. The variety which occurs imbedded in rough crystals and cleavable masses, opaque, and of a dull colour, called corundum, occurs at Canton in China, Battagamnana in Ceylon, Permetty in the Carnatic, Mysore, in the Ural in the auriferous sands of Slatoust among blocks of fine-grained felspar, and in granite near Miask, in felspar at Mozzo in Piedmont, in magnetic iron ore at Gelliware in Sweden, Lapland, at Newton in New Jersey, in Maryland and Connecticut, in the valley of Chamounix, in dolomite at Campo Longo, in basalt at Niedermendig on the Rhine. The granular and massive variety, called emery, is found at Ochsenkopf near Schwarzenberg in Saxony in a bed of talc in mica slate, in rounded masses in Naxos, Italy, Spain, in great abundance on the summit of Gumuchdagh near Gumuchkeny about twelve miles to the east of Ephesus, and between Eskihissar and Melas in Asia Minor.

The combinations *oarηnρ*, *oarnςvgs*, and indistinct traces of the form *i* were observed in crystals in Mr. Brooke's collection. The faces of the zone *oa* between *n* and *a* are striated to such an extent that it is extremely difficult to distinguish true reflexions from diffraction images, in observing with the reflective goniometer; consequently, the determination of the faces in this zone is liable to considerable uncertainty. Besides the forms enumerated above, Mohs gives $5\ 11\ \bar{1}$ ($5\ 11\ \bar{1},111 = 47^\circ\ 28'$), and Hausmann the forms $5\ 17\ \bar{7}$ ($5\ 17\ \bar{7},111 = 65^\circ\ 22'$), $2\ 17\ \overline{13}$ ($2\ 17\ \overline{13},111 = 81^\circ\ 38'$). Some of the crystals in Mr. Brooke's collection appear to show traces of the forms $3\ 13\ \bar{7}$ ($3\ 13\ \bar{7},111 = 71^\circ\ 44'$), $2\ 11\ \bar{7}$ ($2\ 11\ \bar{7},111 = 76^\circ\ 15'$), $1\ 15\ \overline{13}$ ($1\ 15\ \overline{13},111 =$

85° 30′). The existence of these forms is, however, for the reason above mentioned, extremely doubtful.

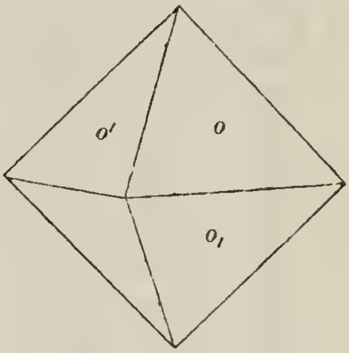
126. PERICLASE.—Periclase; Dufrénoy. Periclas; Hausmann, Haidinger.

Cubic.

a 100 cleavage, *o* 111.

aa′	90°	0′
oo′	70	32
oa	54	44

FIG. 268.



Cleavage. *a*, very perfect. Transparent. Lustre vitreous. Dark green. H = 6·0. G = 3·75.

Infusible before the blowpipe. In powder soluble in acids.

$\dot{\text{Mg}}$, magnesium 61·20, oxygen 38·80.

Analyses *a* by Scacchi, *b*, *c* by Damour:—

	a	*b*	*c*
Magnesia . . .	89·04	92·57	91·18
Protoxide of iron .	8·56	6·22	5·67
Insoluble matter .	—	0·86	2·10

Was found on Monte Somma near Naples.

127. QUARTZ.—Quartz; Phillips. Rhomboedrischer Quarz; Mohs. Quarz; Hauy, Hausmann, Haidinger.

Rhombohedral. 100,111 = 51° 47′.

o 111 twin-face, *a* $01\bar{1}$, *k* $11\,\bar{4}\,\bar{7}$, *r* 100, *z* $\bar{1}22$, *s* $14\bar{2}$, *i* 011, *d* 411, *β* $13\,\bar{2}\,\bar{2}$, *l* $\bar{1}11$, λ $5\bar{1}\bar{1}$, *m* $7\bar{2}\bar{2}$, *γ* $3\bar{1}\bar{1}$, *f* $8\bar{3}\bar{3}$, *ζ* $13\,\bar{5}\,\bar{5}$, *h* $\bar{4}33$, *φ* $\overline{13}\,8\,8$, *ρ* $\bar{7}44$, *v* $16\,\bar{5}\,\bar{8}$, *x* $4\bar{1}\bar{2}$, *y* $10\,\bar{2}\,\bar{5}$, *u* $8\bar{1}\bar{4}$, *t* $\bar{4}\,11\,2$, *θ* $\overline{14}\,22\,7$, *p* $\overline{10}\,14\,5$, *e* $\bar{4}52$, *w* $\overline{14}\,16\,7$, *q* $\overline{16}\,17\,8$, *μ* $\bar{2}21$, *n* $\bar{8}54$, *ξ* $25\bar{1}$, *δ* $22\,19\,\bar{2}$, *η* 11 14 2.

The forms *v*, *x*, *y*, *u*, *s*, *t*, *p*, *θ*, *w*, *q*, *μ*, *n* are hemihedral with asymmetric faces, occurring in one only of the two zones *r′z″b*, *r″z′b*, and in the same alternate lunes between *b*, *b″*, *b′*,… .

The forms η, δ are also hemihedral with asymmetric faces. The faces a, k appear upon the edges of the six-sided prism bb'',… on which v, x, y do not occur.

bo	90°	0′	hb	167°	19′	qb	159°	43′
ao	90	0	ϕb	173	35	μb	161	31
kb	8	27	ρb	175	54	nb	174	39
ba'	30	0	vb	8	52	sa	24	27
bb''	60	0	xb	12	1	ξa	42	17
ζb	7	29	yb	14	35	rr'	85	45
fb	8	9	ub	18	29	rz'	46	16
γb	11	8	bs'	37	58	ηz	63	5
mb	14	42	bz''	66	52	δz	77	20
rb	21	29	br'	113	8	$\delta z''$	16	1
βb	25	17	tb	135	5	δr	39	6
γb	38	13	bs''	142	2	$\delta r'$	46	55
db	57	35	θb	148	22	ηr	49	29
ib	122	25	pb	151	37	$\eta r'$	36	58
zb	141	47	eb	154	55	$\eta r''$	25	37
lb	158	31	wb	157	34			

FIG. 269.

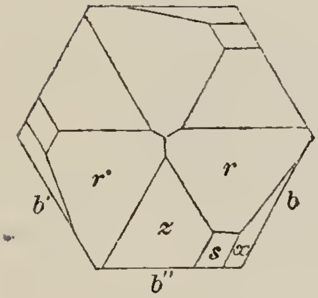


FIG. 270.

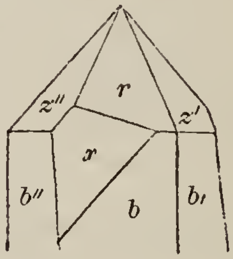


FIG. 271.

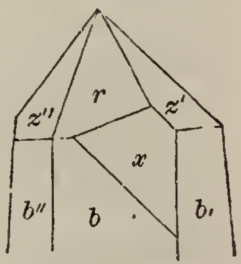


FIG. 272.

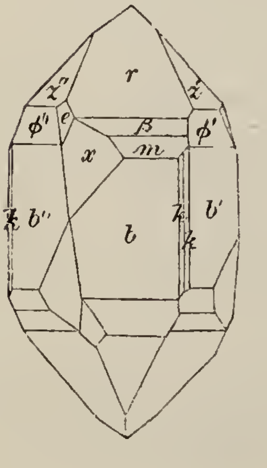


FIG. 273.

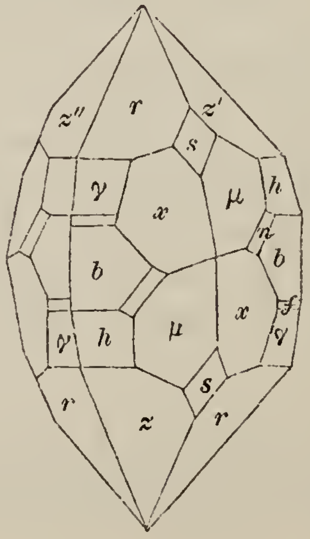


FIG. 274.

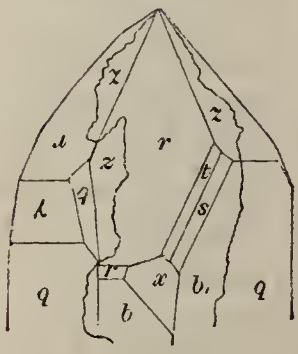
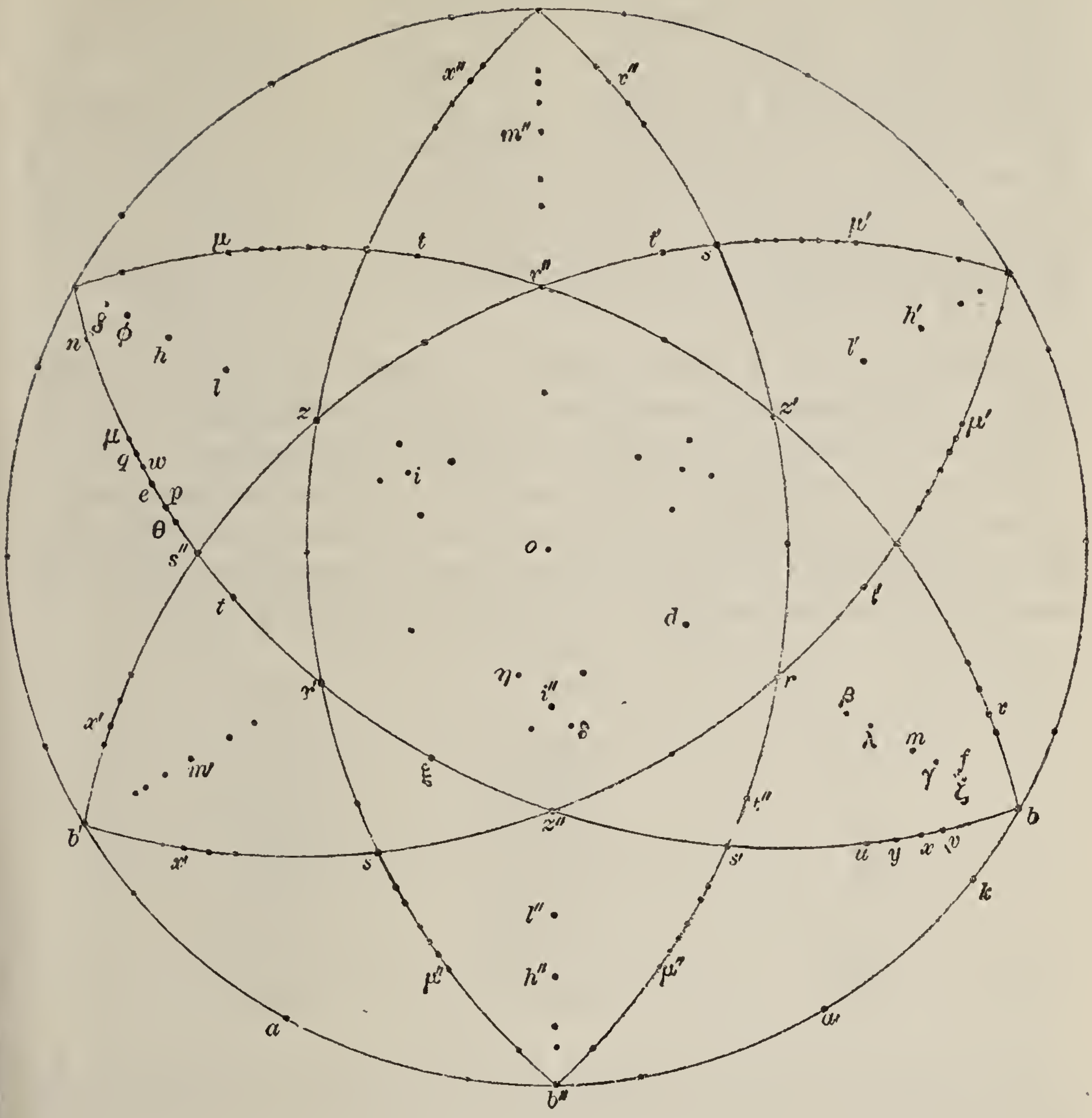
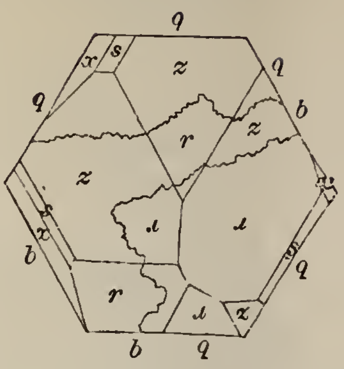


FIG. 275.



Combinations. *brz*, *brzs*, *brzφx*, *brzφax*, *brzλi*, *brzseθxu*, *brzsx*, *brzex*, *brzφsx*, *brzζx*, *brzpfx*, *brzpx*, *brzhmfxuq*, *brzφβmsek*, *brzγfhnusx*, *brzγtsx*, *brzβmlpu*, *brzβhmwqxu*. The faces *b* striated parallel to their intersections with the faces *r*; *z* frequently dull, and smaller than *r*; λ and sometimes γ and *u* rough. Twins. 1. Twin-face *o*. The individuals are frequently united in such a manner as to present the appearance of a single crystal. The faces *s*, *x*, *y*, *u*...are sometimes seen on each angle of one end, or of both ends of the twin crystal, or on three alternate angles of one end and the other three alternate angles of the other end. The hemihedral forms of the two individuals are usually of the same kind; sometimes, however, they are of different kinds. The line of separation of the two individuals is sometimes very irregular, as in fig. 276, where the faces *z* are distinguishable from the faces *r*, by the quality of their surface, the former being covered with irregularities resembling drops of liquid. The light reflected from *r* is reddish, that from *z* greenish. When breathed upon *r* becomes dark yellow, *z* violet. In many instances the faces *z* are dull. 2. Twin-face *ξ*. The axes of the two rhombohedrons make with each other an angle of 84° 34′. 3. Twin-face *r*. The axes of the two rhombohedrons make with each other an angle of 103° 34′.

FIG. 276.



Cleavage. *r*, *z*, *b*, interrupted. Fracture conchoidal...splintery. Transparent...translucent. Lustre vitreous; in some varieties inclining to resinous on surfaces of fracture.

The optical properties are peculiar, the wave surface being a sphere and a prolate spheroid the axis of which is a little less than the radius of the spherical surface. The indices of refraction of rays corresponding to Fraunhofer's lines are :—

	μ	μ'
B	1·54090	1·54990
C	1·54181	1·55085
D	1·54418	1·55328
E	1·54711	1·55631
F	1·54965	1·55894
G	1·55425	1·56365
H	1·55817	1·56772

If a plate of quartz bounded by planes perpendicular to the axis of the rhombohedron be placed in a polarizing apparatus, the diameters of the coloured rings will be seen to vary on turning the analyzer (the tourmaline plate, Nicol's prism or reflector of blackened glass nearest to the eye) round its axis; and the direction in which it must be turned to enlarge the rings is found to depend upon the situation of the hemihedral faces, when they occur. With a slice of crystal in which either of the faces *v*, *x*, *y*, in the zone *bz″*, is situated as in figs. 270, 272, 269, the axis of the polarizing instrument being horizontal, the upper part of the analyzer must be turned to the observer's left hand to make the rings dilate. With a slice of a crystal in which either of the faces *v*, *x*, *y*, in the zone *bz′*, is situated as in figs. 271, 273, 274, the upper part of the analyzer must be turned to the observer's right hand to make the rings dilate. When the emergent light is polarized by transmission, the incident light being circularly polarized and the emergent light plane polarized, coloured spirals are seen having the form of fig. 277 or 278, according as the slice is taken from a crystal like fig. 270 or 271. When the incident light is plane polarized and the emergent light circularly polarized, the spirals resemble fig. 278 or 277, according as the slice is taken from a crystal like fig. 270 or 271. When the emergent light is polarized by reflexion, the incident light being circularly polarized and the emergent light plane polarized, crystals 270, 271 produce spirals resembling figs. 278, 277 respectively. When the incident light is plane polarized and the emergent light circularly polarized, crystals 270, 271 produce spirals resembling figs. 277, 278 respectively.

FIG. 277.

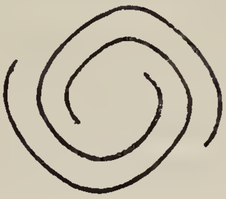
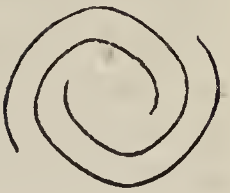


FIG. 278.



The purple variety of quartz, called amethyst, is frequently composed of alternate layers having opposite optical properties, and exhibits traces of this structure in a kind of rippled fracture. When a slice of amethyst or of a twin crystal, bounded by planes perpendicular to the axis, is placed in a polarizing apparatus, at such a distance as to be distinctly seen by the observer, the portions of the individuals of which it consists, may be distinguished from each other, when they have opposite optical properties, by a difference of colour.

When the planes of polarization and analyzation are perpendicular to each other, the centre of the rings is not dark, as is the case with any other uniaxal crystal. Using homogeneous light, the centre becomes dark on turning the analyzing plane, in the direction which enlarges the rings, through an angle proportional directly to the thickness of the slice, and inversely as the square of the length of the undulation of the light employed. The slice of quartz being 0·04 inch thick, the centre becomes dark for different colours, on turning the analyzing plate through the following angles:—

Red	19°·00	Blue	32°·31
Orange . . .	21 ·40	Indigo . . .	36 ·13
Yellow . . .	24 ·00	Violet	40 ·88
Green	27 ·86		

Colourless, white, violet-blue, rose-red, clove-brown, apple-green. Streak white. H = 7·0. G = 2·5...2·8; for the pure varieties G = 2·65.

Infusible before the blowpipe. Exposed to the flame of the oxyhydrogen blowpipe it melts so that it may be drawn into fine threads, and is volatilized. With soda fuses with intumescence into a clear glass. Insoluble in all acids except hydrofluoric acid. Two pieces rubbed together in the dark emit a phosphorescent light and a faint empyreumatic odour.

$\ddot{\mathrm{Si}}$, silicon 48·04, oxygen 51·96.

Analyses *a* of transparent colourless quartz by Bucholz, *b* of a purple variety (amethyst) by Rose, *c*, *d* of a green variety (prasem) by Beudant, *e* of red compact quartz from Sundwich near Iserlohn by Schnabel :—

	a	*b*	*c*	*d*	*e*
Silica	99·37	97·50	95·25	94·84	94·93
Alumina	trace	0·25	0·41	0·47	0·42
Red oxide of iron . .	—	0·50	($\dot{\mathrm{Fe}}$ 2·66	3·64)	3·93
Oxide of manganese .	—	0·25	$\dot{\mathrm{Cu}}$ 1·00	—	—
Magnesia	—	—	0·67	$\dot{\mathrm{H}}$ 1·05	0·73

According to Fuchs, the rose quartz from Rabenstein near Bodenmais owes its colour to the presence of from 1 to 1·5 per cent. of oxide of titanium. The purple colour of some varieties of quartz (amethyst) was generally supposed to be produced by manganese. It was, however, observed by Heintz that a very dark purple amethyst contained less than 0·01 per cent. of manganese, and that it lost its colour at about 250° C; the colouring matter, therefore, cannot be manganese. In 100 parts of a light purple amethyst he found—red oxide of iron 0·0197, lime 0·0236, magnesia 0·0133, soda 0·418. The discoloration by heat, and the presence of soda, are considered favourable to Poggendorff's conjecture that the colour of amethyst is due to the presence of a small quantity of ferric acid.

In attached and imbedded crystals, globular, reniform and stalactitic, fibrous, compact. Also pseudomorphous after datholite, baryte, fluor, gypsum, calcite, barytocalcite, dolomite, scheelite, galena, cerussite, hematite, pyrite, chalybite, pyromorphite. The crystals sometimes contain capillary crystals of epidote, amianthus, amphibole, rutile, antimonite, thin scales of mica, chlorite, silver, copper, mispickel, argentite, pyrite, pyrargyrite and proustite, pyrolusite, hematite, göthite, magnetite, kyanite, stilbite, tourmaline, topaz, calcite, bitumen or drops of very expansible liquids.

A variety of light brownish-red or greenish-grey colour, penetrated by amianthus, and exhibiting a play of light, is called catseye. Avanturine contains numerous minute fissures, which reflect many bright points of light. Chalcedony appears to be an intimate mechanical mixture of crystalline and amorphous quartz, botryoidal, reniform, stalactitic. It is called carnelian when of a red, yellow, or brown colour; plasma when dark green; chrysoprase when of an apple-green colour, produced by the admixture of 1 per cent. of oxide of nickel. Heliotrope is a mixture of chalcedony with earthy chlorite. It is dark green with red or yellow spots. Chalcedony in alternate layers of different colours is called onyx. In irregular layers, or containing dendritic markings, it is called agate. Flint is a variety of chalcedony found in nodules in the upper chalk. Jasper, flinty slate, and hornstone, are variously-coloured mixtures of quartz with alumina, lime, carbon, oxides of iron, manganese, &c.

Quartz occurs as an essential constituent of various rocks, as granite, gneiss, mica slate, topaz rock. The finest crystals are found in the mountains of Switzerland, the Tyrol and Salzburg, Dauphiné, Madagascar, Ceylon and the Brazils; smaller crystals at Quebec; implanted in drusy cavities in granular limestone at Carrara in Italy; isolated in the county of Marmarosch in Hungary; of a brown colour in many places in Bohemia, in the Morne mountains in Ireland and in Siberia; of a pale violet-blue in Hungary, the Tyrol and Siberia; the purple variety called amethyst in Hungary, Porkura in Transylvania, Siberia, the Brazils, in many parts of India and Persia, in pebbles in Ceylon; in the Harz, Saxony, Silesia, Scotland, Spain, &c., in veins, and in agate balls. A rose-red variety is found at Rabenstein near Zwiesel in Bavaria, and in Siberia; of paler colour at Königswerth in Bohemia; milk-white in Norway, Greenland, Spain, France. Chalcedony is found in Trevascus mine in Cornwall, Haytor in Devonshire (pseudomorphous after datholite), Scotland, Greenland, Iceland, the Faröe islands. Agate in the cavities of amygdaloidal rocks, at Oberstein, near Vicenza, in Hungary and Transylvania, Chemnitz, Freyberg, Schneeberg in Saxony, and in various places as the substance of petrifactions. Carnelian in Arabia, India, Surinam, Siberia. Flint in nodules and small beds, enclosing sponges, alcyonia, echinites and other fossils, is found in the chalk formation in the islands of Rügen, Moen, Jutland, England, the north of Ireland, Champagne in France, the south of Russia, &c.

The forms d, η, δ, θ, ξ were observed by Mr. Brooke in crystals in his collection. For the description of the other forms, the editors are indebted to G. Rose's Memoir on the Crystallization of Quartz, in the 'Berlin Transactions for 1844,' communicated to them by the author.

128. OPAL.—Opal; Phillips. Quarz résinite; Hauy. Untheilbarer Quarz; Mohs. Opal; Hausmann, Haidinger.

Amorphous. Fracture conchoidal. Transparent...translucent. Lustre vitreous, in some varieties inclining to resinous. Colourless, white, yellow, red, brown, green, grey, black. Streak white. Some varieties exhibit a beautiful play of colours. Very brittle. H = 5·5...6·5. G = 1·9...2·3.

The variety called hyalite is transparent...semitransparent; colourless; reniform, botryoidal. Fire opal is transparent; red, yellow, sometimes iridescent. Noble opal, semitransparent... translucent; milk-white, yellowish-white, exhibiting a play of colours. Common opal shows no play of colours. Semiopal is dull and opaque. Cascholong is white and opaque. Siliceous sinter is deposited in fibrous, reniform and botryoidal masses by various hot springs. Hyrophane imbibes water readily, and becomes more transparent in consequence.

In the matrass yields water. Before the blowpipe decrepitates, is infusible. Is almost perfectly soluble in a cold solution of caustic potash. In other respects, the chemical characters are the same as those of quartz.

Consists of amorphous silica with from 5 to 13 per cent. of water, and small quantities of red oxide of iron, alumina, lime, magnesia, potash and soda.

Analyses of hyalite *a* from Frankfort on the Maine by Bucholz, *b* from Hungary by Beudant, *c* from Waltsch in Bohemia by Schaffgotsch, of the red or yellow variety called fire opal *d* from Zimapan in Mexico by Klaproth, of noble opal, exhibiting a play of colour *e* from Cscherwenitza in Hungary, of yellow opal *f* from Telköbanya, both by Klaproth:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	92·00	91·32	95·5	92·00	90·0	93·5
Red oxide of iron .	—	—	0·8	0·25	—	1·0
Lime	—	—	0·2	—	—	—
Water	6·33	8·68	3·0	7·75	10·0	5·0

In hyalite from Zimapan in Mexico the loss by ignition was found to be 2·5...2·9 per cent.; in siliceous sinter from the Geyser 10·6 per cent.

Analyses of opal *g* from Frankfort by Stucke, *h* from Moravia, *i* from Paris (menilite), both by Klaproth; *k* from Castella Monte by Beudant; wood opal (forming the substance of fossil wood) *l* from Oberkassel by R. Brandes; hydrophane *m* from Hubertsburg in Saxony by Klaproth:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	82·75	85·00	85·50	93·2	93·00	93·13
Alumina . . .	3·50	3·00	1·00	—	0·13	1·62
Red oxide of iron	3·00	1·75	0·50	(Ṁg 0·3)	0·37	—
Lime	0·25	—	0·50	0·4	—	—
Water	10·00	8·00	11·00	6·1	6·13	5·25
Carbon	—	1·00	(0·33	bituminous oil)	—	—

Analyses of fire opal *n* from the Faröe islands, of the opaque variety called cacholong *o* from the Faröe islands, both by Forchammer, *p* from Meronitz in Bohemia by Wertheim, siliceous sinter *q* from Iceland by Forchammer, *r* from Iceland by Kersten, of semi-opal *s* from Schiffenberg near Giessen by Wrightson:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	88·73	95·32	83·73	84·43	94·01	90·20
Alumina . . .	0·99	0·20	—	3·07	1·70	1·86
Red oxide of iron	0·25	—	3·58	1·91	—	4·11
Magnesia . . .	1·48	0·40	0·67	1·06	—	0·86
Lime	0·49	0·06	1·57	0·70	sulphuric acid	0·31
Potash	0·34	0·07	—	0·92	—	0·80
Soda		0·06	—		—	0·90
Water	7·75	3·47	11·46	7·88	4·10	2·73

Occurs massive and disseminated; in botryoidal and reniform concretions; also as fossil wood. Hyalite is found near Francfort on the Maine, on the Kaiserstuhl in the Breisgau, in porphyry near Schemnitz in Hungary, in Silesia in many places on quartz rock and serpentine, in Bohemia near Waltsch on basalt, in the islands of Ischia and Graziosa, in Mexico. Siliceous sinter, a product of hot springs, is found incrusting vegetable matter at the Geysers in Iceland, and in Italy. The variety of opal which exhibits a play of colours is found in porphyry at Czerwenitza between Kaschau and Eperies in Hungary, at Zimapan in Mexico, in the amygdaloid of the Faröe islands and in Iceland. The common opal is found at Telköbanya not far from Eperies, and other places in Hungary, at Pernstein and Smrczek in Moravia, Niemczitz and Budweis in Bohemia, Frankenstein, Kosemütz &c. in Silesia, Iceland and Greenland. Wood opal is found at Kremnitz, Libethen, Telköbanya in Hungary, and in many parts of Transylvania, in great stems in sandstone; at Bilin in Bohemia, the Siebengebirge, Hoentwiel in Suabia, near Ahrweiler, in France and in North America.

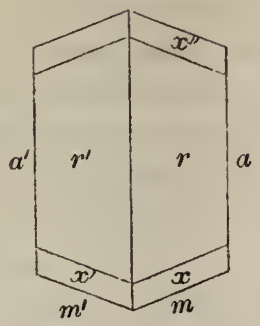
129. VALENTINITE.—Oxide of antimony; Phillips. Antimoine oxidé; Hauy. Prismatischer Antimon-Baryt; Mohs. Antimonblüthe; Hausmann. Valentinit; Haidinger.

Prismatic. 011,010=15° 35′; 101,001=54° 44′; 110,100=68° 29′.

a 100, *s* 103, *r* 101, *v* 401, *m* 110, *x* 211. The faces *s*, *s′* truncate the edge *rr′*; *v* truncates the edge *ra*.

va	10° 2′		*ma*	68° 29′	
ra	35 16		*mm′*	43 2	
sa	64 46		*xa*	52 49	
vv′	159 56		*xx′*	74 22	
rr′	109 28		*xx″*	100 16	
ss′	50 28		*x′x″*	155 17	

FIG. 279.



Combinations. *sm*, *rma*, *rxma*. The faces *r*, *x* curved; *a*, smooth and plane; *m*, sometimes rough, but plane. Cleavage. *m*, very perfect. Fracture not observable. Semitransparent… translucent. Lustre adamantine, especially on the curved faces; *a*, pearly. White, passing into grey, yellow, brown and red. Streak white. Sectile. H = 2·5…3·0. G = 5·566.

In the matrass it sublimes completely. Melts very easily before the blowpipe, sublimes and forms a crystalline deposit on the charcoal. Is reduced in the inner flame, especially when mixed with soda and cyanide of potassium, and colours the flame green. With borax it forms a glass which is yellowish while hot, but becomes almost colourless on cooling. It is readily soluble in nitromuriatic acid. It is precipitated from the solution on the addition of water.

$\overset{\dots}{Sb}$, antimony 84·32, oxygen 15·68.

Analysis of valentinite from Wolfach by Suckow:—

Oxide of antimony $\overset{\dots}{Sb}$	91·7
Red oxide of iron	1·2
Silica	0·8
Antimony	6·3

Valentinite occurs generally in tabular and acicular crystals, in diverging groups of crystals; more rarely in granular, columnar or lamellar masses; as a thin crystalline coating on other minerals; pseudomorphous after antimony.

It is found at Przibram in Bohemia, Bräunsdorf in Saxony, Pernek near Malaczka in Hungary, Wolfach in the Breisgau, Horhausen in Nassau, Allemont in Dauphiné.

Oxide of antimony is dimorphous. Octahedral as well as prismatic crystals are obtained in smelting some of the ores of antimony, and also from a solution of chloride of antimony in boiling carbonate of soda. When sublimed at a high temperature, the crystals belong to the prismatic system; sublimed at a low temperature, it crystallizes in octahedrons. A solution of antimonic oxide in boiling soda crystallizes in octahedrons on cooling in close vessels. If boiling acid hydrochlorate of antimonic oxide be added to a boiling solution of carbonate of soda, prismatic crystals of antimonic oxide are obtained.

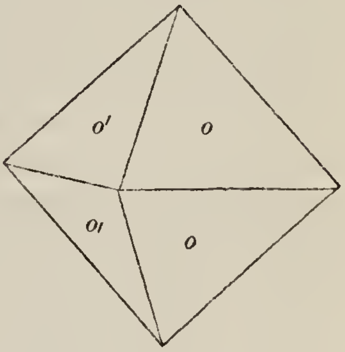
130. SENARMONTITE.—H. de Senarmont. Annales de Chimie. Avril. 1851.

Cubic.

o 111.

oo′ 70° 32′

FIG. 280.



Cleavage. *o*, traces. Fracture uneven, lamellar. Transparent...translucent. Lustre resinous, inclining to adamantine. Colourless. Streak white. H less than 3. G = 5·22...5·30.

Chemical characters the same as those of valentinite.

$\dddot{\mathrm{Sb}}$, antimony 84·32, oxygen 15·68.

Is found in attached crystals, granular and compact masses, at Sensa near the source of the Aïn-el-Bebbouch in the province of Constantine in Algiers.

131. ARSENITE.—Oxide of arsenic; Phillips. Arsenic oxidé; Hauy. Oktaedrische Arsenik-Säure; Mohs. Arsenikblüthe; Hausmann. Arsenit; Haidinger.

Cubic.

o 111.

oo′ 70° 32′ (fig. 280.)

Cleavage. *o*. Fracture conchoidal. Transparent...opaque. Lustre vitreous, inclining to adamantine. $\mu = 1{\cdot}811$. White; yellow or red when mixed with realgar. Streak white. H = 1·5. G = 3·699.

Before the blowpipe on charcoal is volatilized; with soda on charcoal emits a smell of garlic. In the open tube sublimes in small octahedrons. Heated in contact with a splinter of charcoal, or better with a mixture of soda and cyanide of potassium, in a closed tube, metallic arsenic sublimes. Slightly soluble in water. With hydrochloric acid on a plate of copper leaves a grey metallic coating.

$\overset{\cdots}{\mathrm{As}}$, arsenic 75·74, oxygen 24·26.

In crystals, crystalline crusts, and columnar masses, stalactitic, earthy, investing other minerals.

It is probably produced by the decomposition of ores containing arsenic, in veins with metallic arsenic, realgar, proustite, galena, &c. It is found at Joachimsthal in Bohemia, Kapnik in Transylvania, Bieber in Hanau, Markirch in Alsace, Andreasberg in the Harz, Gistain in the Pyrenees.

Sublimed at a high temperature in close vessels arsenious acid is amorphous, glassy and perfectly transparent, G = 3·7385. Exposed to the air, it gradually becomes crystalline and opaque. A solution of glassy arsenious acid in warm hydrochloric acid, on cooling, deposits crystals which, as they form, were observed by H. Rose to become luminous. In the process of roasting cobalt ores containing arsenic, it is sometimes obtained in thin, pearly, flexible, prismatic crystals isomorphous with valentinite. These when sublimed yield octahedrons. A boiling solution of potash saturated with arsenious acid and left to cool, usually deposits prismatic crystals of arsenious acid.

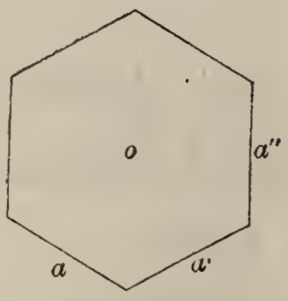
132. ICE.—Eis; Hausmann.

Rhombohedral.

o 111, *a* $01\bar{1}$.

ao	90° 0′
aa′	60 0

FIG. 281.



Combination. *oa*. Twins. Twin-face *a*. Groups of twin-crystals occur frequently in snow, producing star-shaped figures. Cleavage. *o*. Fracture conchoidal. Pellucid in a high degree. Lustre vitreous. The indices of refraction for rays of different colours are as follows:—

Red	1·3070	Green	1·3115
Orange	1·3085	Blue	1·3150
Yellow	1·3095	Violet	1·3170

Double refraction very feeble. The surface of ice formed on still water is the face *o*, the centre of the coloured rings surrounding the optic axis being seen, when placed in a polarizing apparatus, in a direction perpendicular to the surface. Colourless, in large masses greenish or blueish. Sectile, rather brittle. H = 1·5. G = 0·918 at 0° C.

Becomes liquid at 0° C; boils at 100° C.

HO, hydrogen 11·11, oxygen 88·89.

Occurs in the Andes in strata alternating with sandstone, and as glaciers in the Alps and other elevated situations.

According to Breithaupt, combinations of the forms *o*, *a* with three forms the faces of which truncate the edge *oa*, are not unfrequently observed in the levels of the Lorenz Gegentrum mine near Freiberg.

133. IRITE.—Irit; Hausmann, Haidinger.

Cubic.

o 111. (fig. 280.)

Lustre metallic. Iron-black. G = 6·056.

Melted with nitre emits fumes of osmium. Insoluble in acids.

Analysis by Hermann:—

Oxide of iridium $\bar{\mathrm{I}}\mathrm{r}$ . . .	62·86
Protoxide of osmium . .	10·30
Protoxide of iron . . .	12·50
Oxide of chrome	13·70
Oxide of manganese . . .	trace

In fine scales in cavities in the larger pieces of platinum, and in the ferruginous platinum sand of the Ural.

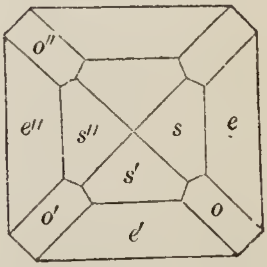
134. HAUSMANNITE.—Hausmanite; Beudant. Pyramidales Mangan-Erz; Mohs. Glanzbraunstein; Hausmann. Hausmannit; Haidinger.

Pyramidal. 101,001 = 58° 57′.

c 001 cleavage, *e* 101, *o* 111, *s* 103.

sc	28°	58′	*ee′*	74°	35′
ec	58	57	*ee″*	117	54
oc	49	36	*oo′*	65	8
ss′	40	3	*oo″*	99	10
ss″	57	56	*eo*	37	18

FIG. 282.



Combinations. *es*, *eos*. The faces *s* very smooth and bright; *e* striated parallel to their intersections with *s*, frequently dull. Twins. Twin-face *o*. Cleavage. *c*, tolerably perfect; *o*, *e* less distinct and interrupted. Fracture uneven. Opaque. Lustre imperfect metallic. Brownish-black. Streak dark reddish-brown, almost chesnut-brown. H = 5·0...5·5. G = 4·7...4·8. Conducts electricity feebly.

Infusible before the blowpipe. Imparts a violet colour to glass of borax. Soluble in warm hydrochloric acid with evolution of chlorine. Concentrated sulphuric acid, to which it has been added in powder, assumes a bright red colour.

$\dot{\text{M}}\text{n} + \dddot{\bar{\text{M}}}\text{n}$, protoxide of manganese $\dot{\text{M}}\text{n}$ 30·89, oxide of manganese $\dddot{\bar{\text{M}}}\text{n}$ 69·02, or protoxide of manganese 93·02, oxygen 6·98.

Analyses of hausmannite *a* from Ihlefeld by Turner, *b* from Ilmenau by Rammelsberg:—

	a	*b*
Protoxide of manganese .	92·00	92·49
Oxygen	7·09	7·00
Barytes	0·11	0·15
Silica	0·34	—
Water	0·44	—

In attached crystals, granular masses and pseudomorphous after manganite and calcite.

Is found in veins in porphyry associated with manganite at Oehrenstock near Ilmenau in Thuringia and at Ihlefeld in the Harz. Is said to occur at Leisa near Battenberg in the neighbourhood of Marburg.

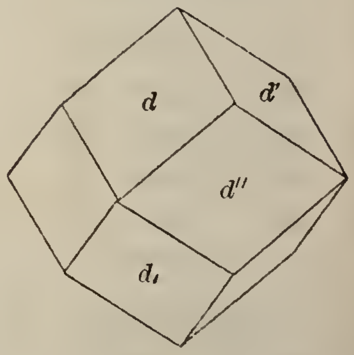
135. FRANKLINITE.—Franklinite; Phillips, Beudant. Dodekaedrisches Eisen-Erz; Mohs. Franklinit; Hausmann, Haidinger.

Cubic.

a 100 cleavage, *o* 111, *d* 011, *n* 211, *p* 122.

aa′	90°	0′
oo′	70	32
oa	54	44
dd′	60	0
do	35	16
no	19	28
nd	54	44
po	15	48
pd	19	28

FIG. 283.



Forms and combinations. *o*, *d*, *od*, *dn*, *odp*. Surface smooth.

Cleavage. *a*, *o* both very imperfect. Fracture conchoidal. Opaque. Lustre metallic. Iron-black. Streak dark brown. Brittle. H = 6·0...6·5. G = 5·07...5·13. Slightly magnetic, without sensible polarity.

Infusible before the blowpipe. With soda on charcoal in the inner flame yields a sublimate of oxide of zinc. In the outer flame imparts a purple colour to glass of borax. Completely soluble in warm hydrochloric acid, forming a yellowish-green solution.

$\dot{\mathrm{R}}\dddot{\mathrm{R}}$, where $\dot{\mathrm{R}}$ is protoxide of iron $\dot{\mathrm{F}}\mathrm{e}$, protoxide of manganese $\dot{\mathrm{M}}\mathrm{n}$ and oxide of zinc $\dot{\mathrm{Z}}\mathrm{n}$, and $\dddot{\mathrm{R}}$ is red oxide of iron $\dddot{\mathrm{F}}\mathrm{e}$ and oxide of manganese $\dddot{\mathrm{M}}\mathrm{n}$.

Analyses of Franklinite by Berthier and Abich :—

Red oxide of iron . .	66·0	68·88
Oxide of manganese .	16·0	18·17
Oxide of zinc	17·0	10·81
Alumina	—	0·73
Silica	—	0·40

In imbedded crystals, angular or rounded grains, and granular masses.

Is found in crystals imbedded in spartalite, and in rounded grains imbedded in calcite, at Franklin and Sterling in New Jersey, with calamine and smithsonite at Altenberg near Aix la Chapelle.

136. MAGNETITE.—Magnetic iron ore ; Phillips. Fer oxidulé ; Hauy. Oktaedrisches Eisen-Erz ; Mohs. Magneteisenstein ; Hausmann. Magnetit ; Haidinger.

Cubic.

a 100, *d* 011, *o* 111, *e* 210, *p* 122, *m* 311, *s* 321, *y* 10 1 1, *z* 16 1 1.

aa′	90° 0′	*mo*	29° 30′
dd′	60 0	*sa*	36 42
da′	45 0	*sa′*	54 41
oo′	70 32	*sa″*	74 30
oa	54 44	*so*	22 13
ea	26 34	*sd″*	19 6
pa	70 32	*ya*	8 3
pa′	48 11	*yo*	46 41
pd	19 28	*za*	5 3
ma	25 14	*zo*	49 41

FIG. 284.

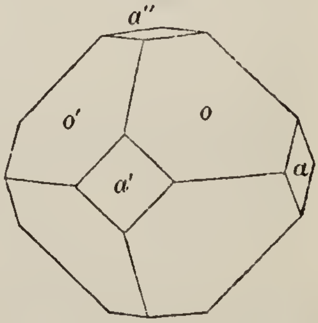


FIG. 285.

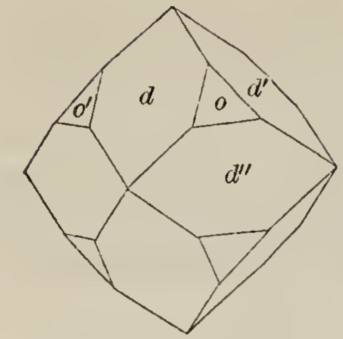


FIG. 286.

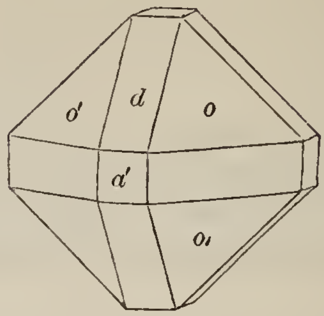
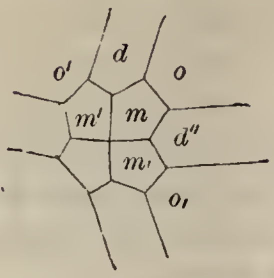


FIG. 287.



Forms and combinations. *a*, *o*, *d*, *ao*, *od*, *ds*, *aod*, *odm*, *odep*, *odems*, *aoyz*. The faces *d* usually striated parallel to their intersections with *o*; *p* smooth but curved; the faces of the other forms usually smooth and even. Twins. Twin-face *o*. Cleavage. *a*, *o* distinct…traces. Fracture conchoidal…uneven. Opaque. Lustre metallic, sometimes imperfect. Iron-black. Streak black. Brittle. H = 5·5…6·5. G = 4·96…5·20.

Fusible before the blowpipe with very great difficulty. In the inner flame imparts a bottle-green colour to borax. In powder is perfectly soluble in warm hydrochloric acid.

$\dot{\mathrm{Fe}}\dddot{\mathrm{Fe}}$, red oxide of iron 68·97, protoxide of iron 35·03, or iron 72·41, oxygen 27·59.

Analyses of magnetite *a* from Norra in Sweden by Berzelius, *b* crystallized from Dannemora in Sweden, *c* massive from Gellivara in Lapland, *d* crystallized from Berggieshübel in Saxony, *e* crystallized from the Tyrol, all by Karsten, *f* crystallized by Fuchs:—

	a	*b*	*c*	*d*	*e*	*f*
Red oxide of iron	69	69·95	69·40	67·95	67·56	68·40
Protoxide of iron	31	29·53	28·25	29·92	28·66	30·88
Titanic iron oxide	—	0·25	—	—	3·31	—
Earthy matter .	—	0·15	—	1·86	—	—

In attached and imbedded crystals, and disseminated, in chlorite slate, serpentine, granite, syenite, basalt, &c.; usually massive in beds with augite, amphibole, garnet, quartz, calcite, pyrite, hematite, in gneiss, mica slate, chlorite slate, hornblende slate, clay slate, greenstone, marble, very seldom in veins; sometimes in rounded grains in alluvium in streamworks with gold, platinum and various gems.

Is found in enormous masses in Norway near Arendal and other places in Sweden, Dannemora in Upland, the island of Utö, near Norberg in Westmanland, Philipstad in Wermeland, on the Grengesberg in Dalarne, on the Taberg mountains in Smaland, in Lapland in the mountains Kurunavara and Luossavara in Tornea Lappmark, Gellivara in Lulea Lappmark; in the Ural in Wissokaja Gora near Nischne-Tagilsk, Blagodat near Kuschwinsk, Kaschkanar near Nischne-Turinsk, Ulu-Utasse-Tau near Magnitnaja; in the Harz, Saxony, Bohemia, Stiria, Moravia, Silesia, Corsica, Elba, Savoy, the Asturias, near Marbella in Spain, New York, New Jersey, Pennsylvania, Virginia, New Hampshire, Maine, and Connecticut; in Mexico, the Brazils, the East Indies; in serpentine in Unst, Cornwall, Wicklow in Ireland. Is found in crystals at Fahlun, in many places in the Ural, in the Zillerthal in the Tyrol, Kraubat in Stiria, Traversella in Piedmont, in the Brazils, near Tavistock in Devonshire, in attached crystals in the cavities of amygdaloid in the county of Antrim in Ireland, in the matter ejected by Vesuvius. It occurs as sand in the gold and platinum stream-works in the Ural and in America. Crystals of magnetite are frequently formed when iron at a high temperature is exposed to atmospheric air or to the vapour of water. Some varieties from the Brazils and from Kalinowkoi near Beresowsk in Siberia appear to be wholly or partly changed into hematite, retaining their form and cleavage. The streak in these cases is reddish-brown, and the magnetic power is impaired, but not wholly destroyed. Magnetite appears sometimes to contain a mechanical mixture of hematite.

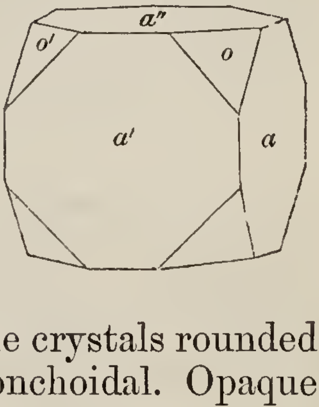
137. ISERINE.—Iserine; Phillips. Fer oxidulé titanifere; Hauy. Hexaedrisches Eisen-Erz; Mohs. Titaneisenstein; Hausmann. Iserin; Haidinger.

Cubic.

a 100, *d* 011, *o* 111.

aa′	90°	0′
dd′	60	0
da′	45	0
oo′	70	32
oa	54	44
od	35	16

FIG. 288.



Combinations. *ao*, *ad*, *od*. The faces of the crystals rounded, rough. Cleavage not perceptible. Fracture conchoidal. Opaque. Lustre metallic, imperfect; bright on the surfaces of fracture. Iron-black. Streak black. Brittle. H = 6·0...6·5. G = 4·86...5·10. Magnetic.

Infusible before the blowpipe. With salt of phosphorus in the inner flame yields a reddish glass.

$\dot{\mathrm{Fe}}\dddot{\cancel{\mathrm{R}}}$, where $\dddot{\cancel{\mathrm{R}}}$ is $\dddot{\cancel{\mathrm{Fe}}}$ and $\dddot{\cancel{\mathrm{Ti}}}$.

Analyses *a* of the slag-like iserine from the basalt of Unkel on the Rhine by Rammelsberg, *b* of the strongly magnetic iserine from the decomposed basalt of the Virneberg near Rheinbreitenbach, G = 5·1, by Rhodius :—

	a	*b*
Titanic acid	11·51	9·63
Red oxide of iron . .	48·07	51·86
Protoxide of iron . .	39·16	40·27

$\dddot{\cancel{\mathrm{Ti}}}$ is supposed to be converted into $\ddot{\mathrm{Ti}}$ by combining with a portion of the oxygen in the $\dddot{\cancel{\mathrm{Fe}}}$ during the analysis.

Occurs in imbedded crystals, massive and disseminated in basalt and dolerite, and in the form of sand in alluvium.

Is found in Bohemia on the Feuermauer near Krzmusch in the neighbourhood of Töplitz and at Schima, in Saxony in the Kirnitz brook near Schandau, on the Scheibenberg, Zittau, the Eisberg near Herrnhut in Upper Lusatia, at Unkel, Laach, Niedermendig and Rheinbreitenbach on the Rhine, Puy de Dome in France, Calabria. The magnetic sand found in a rivulet near Menaccan in Cornwall is probably iserine.

Talkeisenerz appears to be a variety of iserine containing some alumina and magnesia. Cleavage. *a*, imperfect. H = 5·5...6·0. G = 4·40...4·45. Feebly magnetic. Is found with black spinelle at Warwick in New York.

138. CHROMITE.—Chromate of iron; Phillips. Fer chromaté; Hauy. Oktaedrisches Chrom-Erz; Mohs. Chromeisenstein; Hausmann. Chromit; Haidinger.

Cubic.

o 111.

oo′ 70° 32′. (fig. 280.)

Cleavage. *a*, *o* traces. Fracture uneven...imperfect conchoidal. Opaque. Lustre metallic, inclining to resinous. Iron-black...brownish-black. Streak dark brown. Brittle. H = 5·5. G = 4·40...4·59. Sometimes slightly magnetic. Conducts electricity feebly.

Unchangeable before the blowpipe. The unmagnetic varieties become magnetic in the inner flame. Slowly but completely soluble in borax and salt of phosphorus, showing the colour of iron while hot, and the green of chrome when cold. After fusion with nitre yields with water a yellow solution, which affords the reaction of chrome. Soluble in bisulphate of potash.

$\dot{\mathrm{R}}\overset{\cdots}{\mathrm{R}}$, where $\dot{\mathrm{R}}$ is $\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{C}}\mathrm{r}$ and $\overset{\cdots}{\mathrm{R}}$ is $\overset{\cdots}{\mathrm{C}}\mathrm{r}$, $\overset{\cdots}{\mathrm{A}}\mathrm{l}$ and perhaps $\overset{\cdots}{\mathrm{F}}\mathrm{e}$.

Analyses of chromite *a* from Röraas by v. Kobell, from Baltimore *b* crystallized, *c* massive by Abich, *d* from the gold mines of Beresowsk by Moberg, *e* from Bolton in Canada, *f* from Memphramagog in Canada, both by T. S. Hunt:—

	a	*b*	*c*	*d*	*e*	*f*
Oxide of chrome . .	54·08	60·04	44·91	58·40	45·90	49·75
Alumina	9·02	11·85	13·85	10·83	3·20	11·30
Protoxide of chrome .	—	—	—	5·17	—	—
Protoxide of iron . .	25·66	20·13	18·97	18·42	35·68	21·28
Magnesia	5·36	7·45	9·96	6·68	15·03	18·13
Silica	4·83	—	0·83	0·91	—	—

In imbedded crystals and grains, in granular masses, usually disseminated, in alluvium.

Is found in nodules in serpentine near Gassin in the department of Var in France; in irregular veins on the Gulsen near Kraubat in Stiria; in limestone near Portsoy in Banfshire, and Buchanan in Stirlingshire; in large quantities in serpentine on the islands of Unst and Fetlar; in Silesia at Grochau, Silberberg, Hartenberg; in Moravia at Hrubschütz in considerable quantities; in Bohemia at Ronsberg and Altsmoliwetz disseminated in serpentine; in Norway near Röraas; in Siberia at Katharinenburg in large masses, and in several other places disseminated in serpentine, and in small grains and octahedrons in the gold and platinum stream works; in Maryland, Pennsylvania, Vermont, Massachusetts, in serpentine and in limestone at Hoboken in New Jersey, and massive and crystallized in limestone on the Bare Hills near Baltimore; as sand in the Isle à Vaches near St. Domingo in the West Indies.

139. SPINELLE.—Spinelle; Phillips. Alumine magnesiée; Hauy. Dodekaedrischer Korund; Mohs. Spinell; Hausmann. Spinell, Berzelin, Chlorospinell; Haidinger.

Cubic.

d 011, *o* 111, *m* 311, *p* 122.

oo′	70°	32′	*mo*	29°	30′	*m′m,*	50°	28′
dd″	60	0	*m′d*	31	29	*po*	15	48
do	35	16	*mm′*	35	6	*pd*	19	28

FIG. 289.

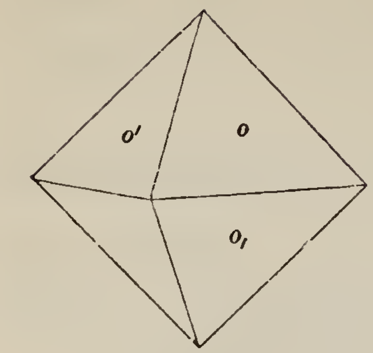


FIG. 290.

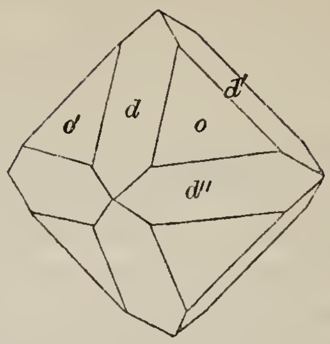
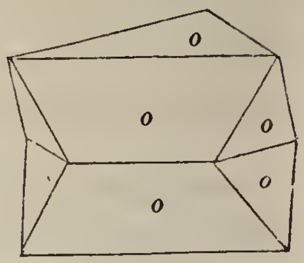


FIG. 291.



Forms and combinations. *o*, *d*, *od*, *odm*, *odmp*. Surface smooth, especially the faces *o* and *m*. *d*, *m* sometimes striated parallel to their intersections with *o*. Twins. Twin-face *o*. Cleavage. *a*, *o* traces. Fracture conchoidal. Transparent... translucent; translucent on the edges only when the colour is dark; opaque when black. Lustre vitreous. White, red, blue, green, brown, yellow, black. Streak white. Brittle. H = 7·5... 8·0. G = 3·523, a transparent red variety. G = 3·77...3·95, black varieties.

The red variety when heated becomes opaque and black, in cooling green, then colourless, and lastly red. In a strong heat pleonaste becomes blue. Infusible before the blowpipe. In powder is soluble in borax and salt of phosphorus into a glass more or less coloured by chrome or iron. Is easily and completely decomposed by fusion with bisulphate of potash. Insoluble in hydrochloric acid. In powder partially soluble in sulphuric acid.

$\dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{A}}\mathrm{l}$, alumina 71·32, magnesia 28·68. Part of the $\dot{\mathrm{M}}\mathrm{g}$ is frequently replaced by $\dot{\mathrm{F}}\mathrm{e}$, and sometimes part of the $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ is replaced by $\dddot{\bar{\mathrm{F}}}\mathrm{e}$.

Analyses *a* of red spinelle from Ceylon, *b* of blue spinelle from Aker, *c* of black spinelle (pleonaste) from the dolomite of Monte Somma, all by Abich, *d*, *e* of green spinelle, G = 3·591 ...3·594 (chlorospinelle), from Slatoust by H. Rose, *f* of black spinelle from Arendal by Scheerer:—

	a	*b*	*c*	*d*	*e*	*f*
Alumina . . .	69·01	68·94	62·84	57·34	64·13	55·17
Red oxide of iron	—	—	6·15	14·77	8·70	$\dot{\mathrm{M}}\mathrm{n}$ 2·71
Magnesia . . .	26·21	25·72	24·87	27·49	26·77	17·65
Protoxide of iron	0·71	3·49	3·87	($\dot{\mathrm{C}}\mathrm{a}$	0·27)	18·33
Silica	2·02	2·25	1·83	($\dot{\mathrm{C}}\mathrm{u}$ 0·62	0·27)	5·09

Analyses of black spinelle (pleonaste), *g* from the Ural, *h* from Fassathal, *i* from Vesuvius, *k* from Iserwiese, all by

Abich, *l* from Ceylon by C. Gmelin, *m* from Ronsperg, G = 3·91 …3·95 (hercynite), by Quadrat:—

	g	*h*	*i*	*k*	*l*	*m*
Alumina . . .	67·46	66·89	65·27	59·66	57·20	61·17
Magnesia . . .	25·94	23·61	17·58	17·70	18·24	2·92
Protoxide of iron .	5·06	8·07	13·97	19·29	20·51	35·67
Silica	2·38	1·23	2·50	1·79	3·15	—

In attached and imbedded crystals and granular masses.

The red variety occurs in isolated crystals and grains in alluvial soil, and in the sand of rivers, in Ceylon, Ava and Mysore; also, it is said, imbedded in gneiss and granite in Ceylon. The blue varieties occur imbedded in granular limestone at Aker in Sweden; Rohleta and Loju Soken in Finland, and Straskau in Moravia; in the dolomite of Nalande and Candi in Ceylon. The black varieties called pleonaste are found in Ceylon; in Bohemia on the Iserwiese, and in the beds of pyrope in rounded crystals and pebbles, at Ronsperg (hercynite); near Montpellier; in the Tyrol on the Monzoni mountain in Fassathal, massive and in crystals, imbedded in compact gehlenite with mica, idocrase, calcite; coating the drusy cavities of rocks ejected by Vesuvius, with augite, amphibole, mica, &c.; in the volcanic rocks of Laach near Andernach; in the Ural in the stream-works of Barsowskoi, with chondrodite in granular limestone and serpentine at Amity and Warwick in New York. The white variety is found at La Ricia near Rome with black garnet and green augite. The grass-green variety (chlorospinelle) is found in the chlorite slate of Slatoust in the Ural.

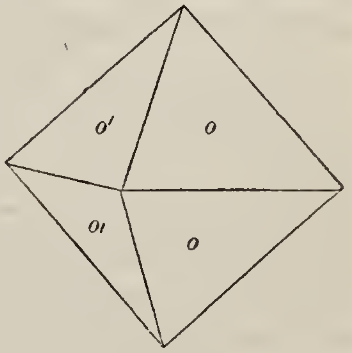
140. GAHNITE.—Automalite; Phillips. Spinelle zincifere; Hauy. Oktaedrischer Korund; Mohs. Gahnit; Hausmann, Haidinger.

Cubic.

a 100 cleavage, *o* 111.

aa′	90°	0′
oo′	70	32
oa	54	44

FIG. 292.



Twins. Twin-face *o*. Cleavage. *a*, usually distinct; *o*, traces. Fracture conchoidal…splintery. Translucent on the edges…opaque.

Lustre vitreous, inclining to resinous. Dark leek-green… blackish-green, greyish-green, blue, black. Streak grey. Brittle. H = 7·5…8·0. G = 4·23…4·49. Conducts electricity feebly.

Infusible before the blowpipe. Nearly infusible in borax and salt of phosphorus. In powder with soda on charcoal, in the inner flame, deposits a sublimate of oxide of zinc on the charcoal. In powder fuses with bisulphate of potash into a mass which is completely soluble in water. Is not acted upon by acids or alcalies.

$\dot{Zn}\dddot{Al}$, part of the $\dot{Zn}$ being replaced by $\dot{Mg}$ and $\dot{Fe}$, and part of the $\bar{Al}$ by $\dddot{\bar{Fe}}$.

Analyses of gahnite *a* from Fahlun, *b* from North America by Abich, *c* of a black variety, G = 4·39, from Bodenmais (kreittonite) by v. Kobell:—

	a	*b*	*c*
Alumina	55·14	57·09	49·62
Red oxide of iron . . .	5·85	—	9·60
Oxide of zinc	30·02	34·80	26·67
Protoxide of iron . . .	—	4·55	7·99
Magnesia	5·25	2·22	3·40
Protoxide of manganese .	traces	traces	1·44
Silica	3·84	1·22	—

According to H. Rose the silica is derived either from a mechanical mixture of quartz, or from the agate mortar in which the mineral was reduced to powder.

In imbedded crystals; granular masses; disseminated.

Is found in Sweden in Eric Matts mine near Fahlun, in talc slate, associated with blende, galena, gadolinite, and garnet, and at Broddbo near Fahlun; massive at Oester Silfberg near Säther and at Garpenberg with quartz; in Finland at Lojo; Bodenmais; Haddam in Connecticut, in granite with beryl, garnet, and cymophane. We have observed some single and twin octahedral crystals, apparently gahnite, imbedded in the interior of a large crystal of garnet from Fahlun.

According to Alger, 'disluite' is to be considered as a variety of gahnite. Cubic. *o* 111. *oo′* = 70° 32′. Yellowish-brown. H = 4·5. G = 4·55. Before the blowpipe dissolves slowly in borax, forming a red glass. Analysis by T. Thomson, as interpreted by Rammelsberg:—alumina 30·49, red oxide of iron 27·96, protoxide of iron 12·55, oxide of zinc 16·80, protoxide of manganese 7·60. Is found with gahnite at Sterling in New Jersey.

141. CHRYSOBERYL. — Chrysoberyl; Phillips. Cymophane; Hauy. Prismatischer Korund; Mohs. Chrysoberyll; Hausmann, Haidinger.

Prismatic. 011,010=39° 1′; 101,001 = 30° 7′; 110,100 = 64° 49′.

a 100, *b* 010, *c* 001 cleavage, *x* 011, *z* 023, *i* 101, *m* 110, *s* 210, *r* 310, *t* 720, *o* 111, *n* 211, *v* 121, *w* 212.

xb	39°	1′	*ma*	64°	49′	*ib*	90°	0′
zb	50	33	*ba*	90	0	*na*	53	52
cb	90	0	*rr′*	109	19	*xa*	90	0
xx′	101	58	*ss′*	86	27	*oo′*	40	7
zz′	78	54	*mm′*	50	22	*oo″*	93	44
ia	59	53	*vb*	25	6	*o′o″*	106	29
ca	90	0	*ob*	43	8	*nb*	51	8
ii′	60	14	*wb*	61	55	*ns*	30	34
ta	31	17						

FIG. 293.

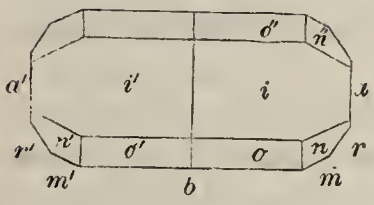


FIG. 294.

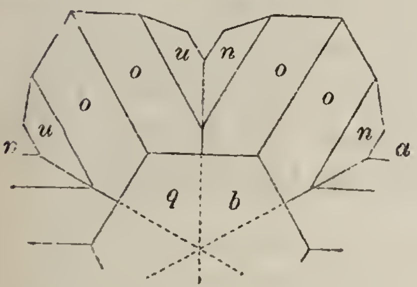
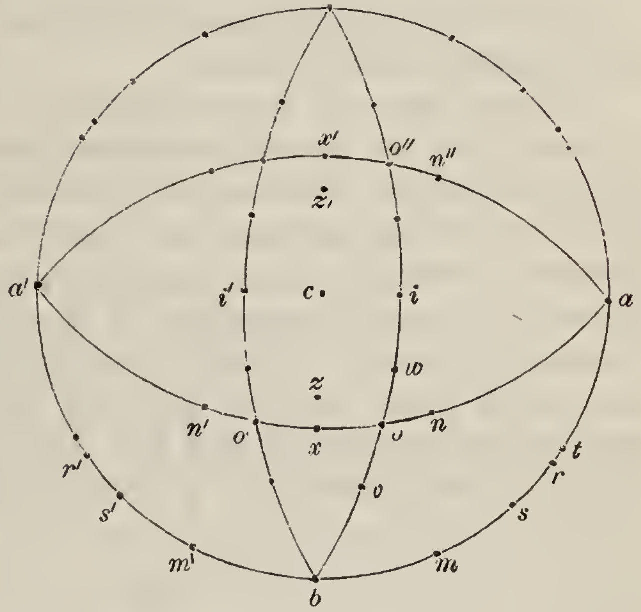


FIG. 295.



Combinations. *iab*, *iosab*, *iorab*, *ionrab*. Twins. Twin-face *i*. The faces *a*, *r*, *s*, *m*, and especially *b*, striated parallel to their intersections with each other; the other faces usually smooth and bright; *i* sometimes rough. Cleavage. *a*, *b* not very perfect, *a* being more distinct than *b*; *c* very faint traces. Fracture conchoidal. Transparent...semi-transparent. Lustre vitreous. The faces *i* and *a* show a blueish opalescence. R=1·76. The optic axes lie in a plane parallel to *a*, and make angles of 76° 5′ with a normal to *b*. Greenish-white, asparagus-green, oil-green, greenish-grey. Exhibits trichroism. Streak white. H = 8·5. G = 3·680...3·754.

Unchanged before the blowpipe. With borax and salt of phosphorus fuses slowly, and with difficulty, into a clear glass. With solution of cobalt becomes blue. Is decomposed by fusion with potash, and by fusion with bisulphate of potash. Is not acted upon by acids.

$\dot{G}\dddot{Al}$, alumina 80·21, glucine 19·79, small portions of the alumina and glucine being replaced by red oxide and protoxide of iron.

Analyses of chrysoberyl *a* from North America by Thomson, *b* from the Ural, G = 3·689, *c* from the Brazils, G = 3·737, both by Awdejew, *d*, *e*, *f* from Haddam by Damour :—

	a	*b*	*c*	*d*	*e*	*f*
Alumina	76·75	78·92	78·10	76·02	74·34	75·43
Oxide of chrome . .	—	0·36	$\dddot{\rlap{-}\mathrm{F}}\mathrm{e}$	4·51	3·53	4·06
Glucine	17·79	18·02	17·94	18·41	19·03	17·93
Protoxide of iron . .	4·49	3·12	4·47	—	—	—
Oxides of Pb, Cu .	($\dot{H}$ = 0·48)	0·29	$\ddot{Si}$	0·49	2·91	0·96

In imbedded and isolated crystals, granular crystalline masses, and in grains and pebbles.

Is found in very large crystals, with phenakite and emerald, in mica slate on the right bank of the river Takowaja, 85 wersts (59 E. miles) to the east of Katharinenburg in the Ural; at Haddam in Connecticut, and near Saratoga in New York, with garnet, tourmaline, and emerald, in gneiss and granite; at Petersdorf near Wiesenberg in Moravia, with garnet, in fibrous quartz in gneiss; in isolated crystals and pebbles in river sand associated with various gems at Saffragang in Ceylon, Pegu, and in the Rio Piauhi and Rio Americanas in the Brazils. The faces *w* were observed in a small crystal from the Brazils.

HYDROUS EARTHS, OXIDES, AND ACIDS.

142. ANTIMONOCHER. — Antimonial ochre; Phillips. Antimoine oxidé; Hauy. Spiesglanzocker; Mohs, Haidinger. Antimonocher; Hausmann.

Amorphous. Fracture uneven, earthy. Opaque. Dull. Yellow. Streak yellowish-white, shining. Brittle. Very soft ...friable. G = 5·28.

In the matrass yields water. Before the blowpipe is volatilized, depositing a white sublimate upon the charcoal. With soda is reduced.

$\overset{\cdot\cdot\cdot}{\mathrm{Sb}}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{Sb}}\dot{\mathrm{H}}^2$, antimony 75·89, oxygen 18·82, water 5·29.

Analysis by Blum and Delffs:—

Antimony	75·83
Oxygen	19·54
Water	4·63
Arsenic	traces

Occurs massive, disseminated, investing other minerals, pseudomorphous after antimonite, from the decomposition of which it results.

Is found with antimonite at Losacio in Spain, Felsöbanya and Kremnitz in Hungary, Goldkronach in Bavaria, the Carmen mine near Zacualpan in Mexico, in Huel Boys near Padstow, and near Port Isaac in Cornwall.

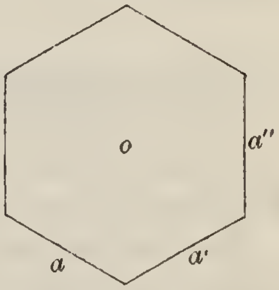
143. **BRUCITE.**—Brucite; Phillips, Beudant. Rhomboedrischer Kuphon-Glimmer; Mohs. Brucit; Hausmann, Haidinger.

Rhombohedral.

o 111, *a* 01$\bar{1}$.

ao	90° 0′
aa′	60 0

FIG. 296.



Cleavage. *o*, very perfect; *a*, traces. Fracture scarcely observable, uneven. Semi-transparent...translucent. Lustre pearly. White, sometimes inclining to grey and green. Streak white. Sectile, in thin leaves flexible. H = 2·0. G = 2·3...2·4.

In the matrass yields water. Before the blowpipe intumesces and becomes opaque, but is infusible. Moistened with solution of cobalt and ignited becomes red. Is easily and perfectly soluble in acids. Exposed to the atmosphere becomes dull, pulverulent, and combines gradually with carbonic acid.

$\dot{\mathrm{Mg}}\dot{\mathrm{H}}$, magnesia 69·62, water 30·38.

Analyses of brucite *a* from Hoboken by Bruce, *b* by Stromeyer, *c* from Unst by Fyfe, *d* from Unst by Stromeyer, *e* by H. Wurtz:—

	a	*b*	*c*	*d*	*e*
Magnesia	70	68·34	69·75	66·67	69·11
Oxide of manganese	—	0·64	—	1·57	—

	a	*b*	*c*	*d*	*e*
Protoxide of iron . .	—	0·12	—	1·18	0·47
Lime	—	—	—	0·19	—
Water	30	30·90	30·25	30·39	30·42

Analyses of the fibrous variety (nemalite) *f* by Connell, *g* by Whitney, *h*, *i* by Wurtz, *k* by Rammelsberg:—

	f	*g*	*h*	*i*	*k*
Magnesia . . .	57·86	62·89	66·05	66·11	64·86
Protoxide of iron .	2·84	4·64	5·63	5·72	4·05
Water	27·96	28·36	30·13	undet.	29·48
Carbonic acid . .	10·00	4·10	—	—	—
Silica	0·80	—	—	—	0·27

According to G. Rose it contains carbonic acid (perhaps derived from the atmosphere), and transparent fragments of the mineral are dissolved with effervescence in hydrochloric acid.

Is found in crystals, and columnar, scaly or granular and fibrous masses, in fissures in serpentine at Hoboken in New Jersey, Staten Island in New York, Swinaness in Unst, near Portsoy in Scotland, Pyschminsk not far from Beresowsk in Siberia.

144. VÖLKNERITE.—Völknerit; Hermann.

In six-sided prisms. Lustre pearly. White. Unctuous to the touch. G = 2·04.

In the matrass yields water. Exfoliates and shines brightly before the blowpipe, but does not melt. Soluble in acids with evolution of carbonic acid.

Analysis by Hermann:—

Alumina	17·65
Magnesia	38·59
Water	43·76

Exclusive of 3·92 per cent. of carbonic acid, supposed to be derived from the atmosphere.

Is found at Schischimskaja Gora in the Ural.

According to Hermann, hydrotalcite, a mineral found in the steatite of Snarum, was originally identical with völknerite. It is cleavable in one direction; translucent, pearly, white inclining to yellow; and according to the analysis by Hochstetter consists of:—carbonic acid 10·54, alumina 12·00, red oxide of iron 6·90, magnesia 36·30, water 32·66, insoluble matter 1·20.

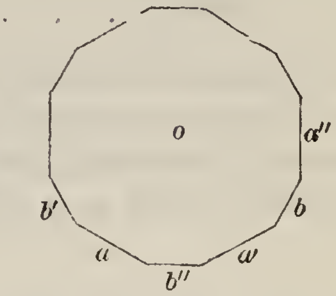
145. HYDRARGILLITE. — Hydrargylite; Dufrénoy. Hydrargillit; Hausmann, Haidinger.

Rhombohedral.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$.

ao	90°	0′
aa′	60	0
ba′	30	0
bb″	60	0

FIG. 297.



Combination. *oba.* The faces *a* striated parallel to their intersections with *b*. Cleavage. *o*, perfect. Lustre, on *a* vitreous; on *o* pearly, bright. Colourless, light reddish-white. H = 2·5...3·0. G = 2·340...2·387.

In the matrass yields water. Before the blowpipe becomes white and opaque, exfoliates and shines with a very bright light, without melting. With solution of cobalt becomes blue. Yields a colourless transparent glass with borax and salt of phosphorus. In fine powder soluble with difficulty in hot sulphuric or hydrochloric acid.

$\overset{\cdots}{\mathrm{Al}}\dot{\mathrm{H}}^3$, alumina 65·55, water 34·45.

Analyses of hydrargillite *a* from Schischimskaja Gora by Hermann, *b* from Cidade d'Ouro Preto by v. Kobell:—

	a	*b*
Alumina	64·03	65·6
Phosphoric acid	1·43	—
Water	34·54	34·4

Is found in very small crystals and granular and scaly masses at Achmatowsk near Slatoust in the Ural, with granular and crystallized magnetite; Cidade d'Ouro Preto in the Brazils; Richmond in Massachusetts.

146. GIBBSITE.— Gibbsite; Phillips. Gibbsit; Mohs, Hausmann, Haidinger.

Feebly translucent. Dull. Greenish, greyish, yellowish-white. Brittle. H = 3·0. G = 2·20...2·44.

In the matrass yields much water, and diminishes in volume. Before the blowpipe in the forceps shines brightly, but does not melt. With solution of cobalt becomes blue. With boracic acid and iron wire yields phosphuret of iron. Is not soluble in boiling hydrochloric acid.

A mixture of $\overset{\cdots}{Al}\,\overset{\cdot\cdot\cdot\cdot\cdot}{P}\,\overset{\cdot}{H}^8$ with $\overset{\cdots}{Al}\overset{\cdot}{H}^3$ in various proportions.

Analyses of gibbsite from Richmond by Hermann :—

Alumina . . .	26·66	38·29	50·20	53·92
Phosphoric acid .	37·62	26·30	15·30	11·90
Water	35·72	35·41	34·50	34·18

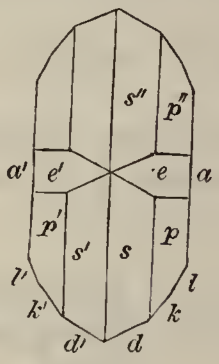
Is found in botryoidal masses at Richmond in Massachusetts. The first analysis represents the composition of the precipitate of hydrous phosphate of alumina, obtained by adding phosphate of soda to a solution of alum.

147. DIASPORE.—Diaspore; Phillips, Hauy. Eutomer Disthen-Spath; Mohs. Diaspor; Hausmann, Haidinger.

Prismatic. 011,010=57° 38′; 101,001=30° 39′; 110,100=46° 56′.

a 100, *c* 001, *e* 101, *d* 120, *k* 320, *l* 210, *p* 111, *s* 122, *o* 922. *o* truncates the edge *pa*.

FIG. 298.



ca	90° 0′		*oa*	23° 56′	
ea	59	21	*ss′*	28	6
ee′	61	18	*ss″*	62	36
ea	28	9	*s′s″*	69	58
ka	35	30	*pp′*	53	10
da	64	57	*pp″*	57	14
dd′	50	6	*p′p″*	81	54
dc	90	0	*oo′*	132	8
sa	75	57	*oo″*	25	4
pa	63	25	*o′o″*	139	56

Combinations. *akdc, akdso, alkdeps*. The edges *sd, ok* rounded. Cleavage. *a*, very perfect; *d*, less perfect. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous; *a*, pearly; on surfaces of fracture resinous. The minimum deviations of light refracted through *dd″* are 21° 54′, 21° 6′ the least refracted ray being polarized in the plane of refraction. Colourless, greyish-white, yellowish-white, greenish-white, pale green, blue, dark violet, yellowish-brown from an admixture of hydrate of red oxide of iron. The variety from Schemnitz appears of a reddish plum-blue colour when viewed in a direction perpendicular to *c*, violet inclining to blue when viewed in a direction perpendicular to *a*, and asparagus green when viewed in a direction parallel to the edge *ae*. Streak white. H = 5·5. G = 3·30...3·43.

In the matrass decrepitates violently, and falls into white shining scales, except the variety from Kosoibrod, which does not decrepitate and is brown after ignition, when heated to redness yields water. Before the blowpipe infusible. Borax and salt of phosphorus dissolve it, after ignition, easily into a clear colourless glass. It is not acted upon by soda. With solution of cobalt becomes blue. Is not acted upon by hydrochloric acid, which dissolves the oxide of iron leaving the mineral colourless. After being strongly ignited is soluble in hydrochloric acid. The Siberian diaspore is soluble in sulphuric acid after ignition.

$\overset{\cdots}{\text{Al}}\dot{\text{H}}$, alumina 85·07, water 14·93.

Analyses of diaspore *a*, *b* from Siberia by Hess, *c* from Sweden, *d* from Siberia, both by Dufrénoy, *e* from Schemnitz by Löwe:—

	a	*b*	*c*	*d*	*e*
Alumina . . .	85·44	85·61	78·93	74·66	85·13
Water	14·56	14·39	15·13	14·58	15·00
Red oxide of iron .	—	—	0·52	4·51	—
Silica	—	—	1·39	2·90	—
Lime	—	—	1·98	1·64	—

Separate crystals are rare, it usually occurs massive, in slightly curved laminæ which are readily separable; also in masses of slender crystals intersecting each other in every direction.

Is found in the Ural at Gornoschit and Kosoibrod with limnite, in narrow veins in chlorite slate; in crystals and radiating masses with pyrite in veins in porphyry in the Crown Prince Ferdinand mine at Schemnitz in Hungary, in dolomite with corundum on St. Gotthardt, Gumuch-dagh near Ephesus, and, as it is said, at Broddbo in Sweden.

The angles of corresponding forms in diaspore and göthite approximate to each other, and, though less closely, to those of manganite.

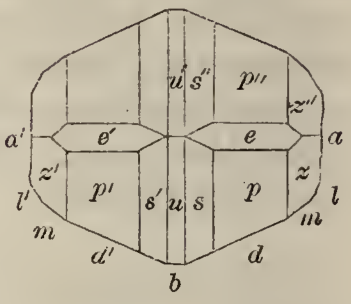
148. GÖTHITE.—Hydrous oxide of iron; Phillips. Fer oxidé hydraté; Hauy. Prismatoidisches Habronem-Erz; Mohs. Pyrrhosiderit; Hausmann. Göthit; Haidinger.

Prismatic. 011,010=56° 33′; 101,001=31° 15′; 110,100=47° 26′.

a 100, *b* 010, *u* 011, *e* 101, *d* 120, *m* 110, *l* 210, *s* 122, *p* 111, *z* 522, *r* 131. *r* truncates the edge *pb*.

ub	56°	33′	*pa*	63°	9′	*r′r″*	128°	32′
cb	90	0	*sa*	75	47	*zb*	70	1
uu′	66	54	*ua*	90	0	*z′z″*	117	44
ea	58	48	*rb*	30	32			
ca	90	0	*pb*	60	32			
ee′	62	30	*eb*	90	0			
la	28	34	*pp′*	53	42			
ma	47	26	*pp″*	58	56			
da	65	20	*p′p″*	83	47			
ba	90	0	*ss′*	28	25			
mm′	85	8	*ss″*	64	43			
dd′	49	20	*sd*	53	55			
za	38	18	*ra*	74	0			

FIG. 299.



Combinations. *adp*, *admp*, *admpe*, *admpes*, *abdmpeur*, *abdmpseuz*. The faces *e* smooth; *p*, *s* faintly striated parallel to their intersections with each other; *p* sometimes rather uneven; *d*, *m* striated parallel to their intersections with each other; the faces *a* frequently greatly enlarged, giving to the crystals the appearance of thin plates. Cleavage. *a*, very perfect. Fracture imperfect conchoidal. Translucent on the edges... opaque. Lustre adamantine. Yellowish-brown, reddish-brown ...blackish-brown. In thin plates and fine needles, hyacinth-red by transmitted light. Streak yellowish-brown. Brittle. H = 5·0...5·5. G = 4·12...4·37.

In the matrass yields water and turns red. Before the blowpipe in the outer flame becomes brownish-red; in the inner flame becomes black and magnetic. Fusible with very great difficulty. With borax and salt of phosphorus affords the reaction of iron. Is easily soluble in hydrochloric acid, frequently leaving a residue of silica.

$\dddot{\bar{\mathrm{F}}\mathrm{e}}\dot{\mathrm{H}}$, red oxide of iron 89·89, water 10·11.

Analyses of crystals (göthite) from Eiserfeld *a* by v. Kobell, *b* by Schnabel, *c* of crystals from Lostwithiel (G = 4·37) by Yorke, of a fibrous variety from Hollerter Zug *d* by v. Kobell, *e* by Brandes, *f* by Schnabel:—

	a	*b*	*c*	*d*	*e*	*f*
Red oxide of iron .	86·35	89·27	89·55	85·65	88·00	84·24
Oxide of manganese .	0·51	0·65	0·16	2·50	0·50	2·45
Oxide of copper . .	0·91	—	—	—	—	—
Water	11·38	10·08	10·07	11·50	10·75	12·68
Silica	0·85	—	0·28	0·35	0·50	0·63

Analyses of fibrous varieties *g* (lepidokrokite) from Oberstein G = 4·1, by v. Kobell, *h* from the Huth mine near Hamm by Schnabel; of compact varieties, *i* from the Huth mine by Karsten, *k* from Saxony, *l* from Maryland, both by v. Kobell, *m* from Chile (chileite) by Plattner:—

	g	*h*	*i*	*k*	*l*	*m*
Red oxide of iron . .	90·53	83·51	86·13	86·34	86·32	83·5
Oxide of manganese .	—	4·72	0·75	ox. copper		1·9
Water	9·47	11·35	11·42	11·66	10·80	10·3
Silica	trace	0·42	1·70	2·00	2·88	4·3

In small attached acicular and tabular crystals, in capillary crystals enclosed in quartz, in reniform and botryoidal masses having a columnar or fibrous structure with a rough or velvet-like surface, in columnar and granular masses, pseudomorphous after pyrite.

Occurs in veins and cavities with quartz and limnite. Is found in crystals at Clifton near Bristol in geodes of quartz, Restormel mine near Lostwithiel and Botallack in Cornwall, at Oberstein in acicular crystals enclosed in crystals of quartz, Landsberg in Rhenish Bavaria, Siebenhitz near Hof in Bavaria, Horhausen in Nassau, near Hirschberg in Voigtland, Schneeberg, Nieder Planitz and Geier in Saxony, Finkelhübel near Glatz in Silesia; in the Drkolnow mine, Reichenberg, and Woina near Przibram in Bohemia, Nadabula near Rosenau in Hungary; enclosed in quartz in the Wolkostrow and Kischj islands in the lake Onega, and pseudomorphous after pyrite at Lewaschowka in the government of Orenburg in Russia, Mount Sinai, Antonio Pereira in the Brazils.

149. MANGANITE.—Grey oxide of manganese; Phillips. Acerdèse; Beudant. Prismatoidisches Mangan-Erz; Mohs. Graubraunstein; Hausmann. Manganit; Haidinger.

Prismatic. 011,010 = 57° 7′·5; 101,001 = 28° 35′; 110,100 = 49° 50′.

a 100, *b* 010, *c* 001, *u* 011, *w* 021, *e* 101, *y* 310, *t* 520, *l* 210, *k* 320, *m* 110, *i* 340, *d* 120, *h* 140, *p* 111, *n* 211, *s* 122, *g* 133, *v* 221, *x* 635. The form *x* is hemihedral with inclined faces.

bc	90°	0′	*ta*	25°	21′	*ha*	78°	5′
ca	90	0	*la*	30	38	*ll′*	118	48
uu′	65	41	*ka*	38	18	*kk′*	103	24
ww′	104	28	*ma*	49	50	*mm′*	80	20
ee′	57	10	*ia*	57	40	*dd′*	45	46
ya	21	33	*da*	67	7	*na*	47	32

pm	49°	49′	nn'	84°	56′	ss'	25°	47′
nl	38	18	nn''	47	10	ss''	53	50
xl	52	46	$n'n''$	103	24	$s's''$	70	2
nb	66	25	pp'	49	11	gg'	17	21
vv'	67	24	pp''	59	6	gg''	64	50
vv''	92	24	$p'p''$	80	22	$g'g''$	67	42
$v'v''$	61	15	sd	54	59			
xa	58	38						
$x'x''$	74	28						

FIG. 300.

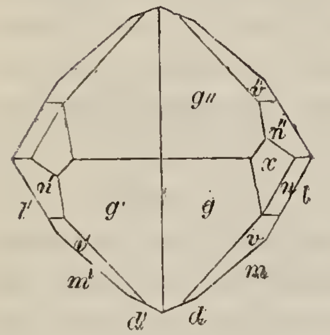
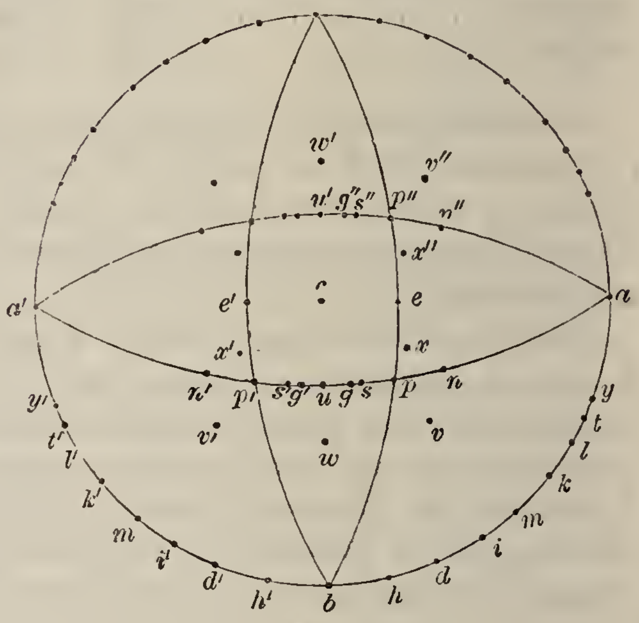


FIG. 301.



Combinations. *cm*, *cmk*, *umk*, *gnvmldx*, *usepvmkld*. The faces *c* striated parallel to their intersections with *u*; *u* striated parallel to their intersections with *p*; the faces of the zone *mm′* striated parallel to their intersections with each other. Most of the faces smooth and bright. Twins. Twin-face *e*. Cleavage. *a*, very perfect and easily obtained; *m*, perfect; *b*, *c* traces. Opaque. Lustre metallic, imperfect. Dark steel-grey...iron-black, brownish-black, velvet-black; sometimes iridescent. Streak reddish-brown. Brittle. H = 3·5...4·0. G = 4·22...4·34. Conducts electricity.

In the matrass yields water. Infusible before the blowpipe. Imparts an amethyst colour to borax and salt of phosphorus in the outer flame, which disappears in the inner flame. Soluble in hydrochloric acid with disengagement of chlorine. Very slightly soluble in concentrated sulphuric acid, colouring it faintly red.

$\overset{\cdots}{\mathrm{\cancel{M}n}}\dot{\mathrm{H}}$, manganese 62·55, oxygen 27·24, water 10·21.

Analyses of manganite *a* from Undenäs by Arfvedson, *b* from Ihlefeld by L. Gmelin, *c*, *d* from Ihlefeld by Turner:—

	a	*b*	*c*	*d*
Manganese	89·92	62·86	62·68	62·77
Oxygen		27·64	27·22	27·13
Water	10·08	9·50	10·10	10·10

In attached and imbedded crystals, columnar and granular masses.

Occurs in irregular veins in porphyry with pyrolusite and other ores of manganese, baryte, calcite and rarely aragonite; also in veins in gneiss with quartz, and in beds of chalybite and hydrous iron oxides; occasionally in the cavities of amygdaloidal trap. Is found in veins in gneiss near Ihlefeld in the Harz, Ilmenau and Oehrenstock in Thuringia, Aberdeenshire, Christiansand in Norway, Undenäs in Sweden, Nova Scotia.

It appears to result sometimes, together with göthite, from the decomposition of chalybite, when the latter contains köhlerite. It is frequently converted into pyrolusite, its colour, hardness and specific gravity being changed at the same time. An intimate mixture of manganite and pyrolusite sometimes occurs in pseudomorphous forms after calcite; this mixture appears to be identical with the substance called varvicite.

150. TURGITE.—Turgit; Hausmann, Haidinger.

Fracture even, conchoidal. Opaque. Dull. Brownish-red. Streak blood-red, shining. H = 5·0. G = 3·56...3·74.

In the matrass yields water. Before the blowpipe becomes darker, but undergoes no farther change. The reactions with fluxes are the same as those of pure red oxide of iron.

$\dddot{\bar{F}}e^{2}\dot{H}$, red oxide of iron 95·27, water 4·73.

Analysis by Hermann:—

Red oxide of iron	85·34
Water	5·31
Oxides of copper and lead	1·85
Silica and insoluble matter	7·50

Occurs massive in the Turginsk copper mines near Bogoslowsk in the Ural, and in those of Solotuschenskoi in the district of Kolywan in the Altai.

151. LIMNITE.—Brown hematite; Phillips. Fer oxidé hydraté; Hauy. Untheilbares Habronem-Erz; Mohs. Brauneisenstein; Hausmann. Limonit; Haidinger. Limnit; Glocker.

Opaque. Lustre resinous, inclining to vitreous. Yellowish-brown...blackish-brown. Streak yellowish-brown. Brittle. H = 5·0...5·5. G = 3·4...3·95. Conducts electricity.

In the matrass yields water. Before the blowpipe on charcoal becomes black and magnetic. With borax in the inner flame melts into a green glass. Is soluble in warm hydrochloric acid, frequently leaving a residue of gelatinous silica.

$\overset{\cdots}{\bar{\mathrm{F}}\mathrm{e}}{}^2\mathrm{H}^3$, red oxide of iron 85·56, water 14·44, usually containing an admixture of silica.

Analyses of limnite *a* fibrous from Horhausen by Schönberg, *b* pitchy iron ore from Siegen, *c* fibrous from Kamensk in the government of Perm, *d* pseudomorphous after pyrite, all by v. Kobell, *e* very pure 'glaskopf' from the Kuhbach mine near Rübeland in the Harz by Amelung, *f* from Cornwall, G = 3·98, by Yorke:—

	a	*b*	*c*	*d*	*e*	*f*
Red oxide of iron	82·27	82·87	83·38	82·24	86·77	82·16
Phosphoric acid .	—	3·00	oxide of manganese			1·13
Water	13·26	13·46	15·01	13·26	13·23	14·28
Silica	4·50	0·67	1·61	4·50	—	2·42

Occurs in fine fibres united into globular, reniform and stalactitic aggregations, having a radiating fibrous or curved lamellar structure; compact and earthy; pseudomorphous after calcite, quartz, galena, fluor, blende, baryte, chalybite, pyrite, marcasite, wood and various shells. Is supposed to result from the decomposition of chalybite, pyrite, &c.

Is found in Carinthia at Hüttenberg and in the valley of the Lavant, in Stiria in beds in gneiss with calcite at Turrach and Eisenerz, in Hungary at Sirk, Dreiwasser near Rhonitz and in the county of Gömör, in the Riesengebirge in mica slate near Starkenbach, in Saxony at Schneeberg and Schwarzenberg, in Thuringia at Kamsdorf and Saalfeld, in Nassau, the Harz, the Tyrol, the Black Forest, Bohemia, Upper Silesia, in extraordinary quantity in the Pyrenees, at Somorostro near Bilbao and other places in the Basque provinces of Spain, in Scotland at Cumberhead in Lanarkshire, in Mainland one of the Shetland isles, and in Hoy one of the Orkneys, in Cornwall at Botallack near the Land's End and in Tin Croft mine near Redruth, in Siberia, in the Brazils at Villa Ricca and Antonio Pereira, in the United States.

152. WAD.—Wad; Phillips. Manganèse oxidé hydraté (in part); Hauy. Schaumartiger Wad-Graphit; Mohs. Manganschaum; Hausmann. Wad; Haidinger.

Amorphous. Opaque. Lustre imperfect metallic, feeble. Clove-brown, passing into grey. Streak brown, shining. Soils. Very sectile. Unctuous to the touch. H = 0·5. G = 2·179... 3·700. Conducts electricity.

In the matrass yields water. The reactions before the blowpipe are the same as those of oxide of manganese.

Analyses of wad *a* from Upton Pyne by Turner, *b* from Rübeland in the Harz by Rammelsberg, *c* from Ilmenau by Scheffler, *d* from Krummau in Bohemia, G = 2·179, by Kussin, *e* from Mossebo in Westgothland by Ingeström :—

	a	*b*	*c*	*d*	*e*
Protoxide of manganese .	73·60	67·50	66·5	64·40	74·17
Oxygen	14·34	13·48	12·1	7·37	8·34
Red oxide of iron . .	—	1·01	1·0	11·12	0·77
Lime	—	4·22	—	—	1·91
Barytes	—	0·36	8·1	magnesia	0·69
Potash	—	3·66	—	—	—
Water	10·66	10·30	9·8	14·10	5·58
Silica	—	0·47	2·5	—	1·43

Occurs massive, botryoidal, sometimes pulverulent, or in froth-like coatings on other minerals.

Is found at Elbingerode and Iberg in the Harz, Kemlas and Arzberg in Franconia, Siegen, Nassau, Hüttenberg, Friesach, Loben and other places in Carinthia, Piedmont, in France at Cantern, Groroi in the department of Mayenne, Vicdessos in the department of Arriège, Cornwall and especially in the manganese pits of Upton Pyne in Devonshire.

153. ASBOLANE.—Earthy cobalt; Phillips. Cobalt oxidé noir; Hauy. Untheilbarer Psilomelan-Graphit; Mohs. Kobaltschwärze; Hausmann. Asbolan; Haidinger.

Amorphous. Fracture conchoidal. Opaque. Lustre resinous, glimmering...dull. Blueish and brownish-black...blackish-blue. Streak black, shining. Soils slightly. Sectile. H = 1·0... 1·5. G = 2·2.

In the matrass yields water having an empyreumatic smell. Before the blowpipe on charcoal emits a smell of arsenic, but does not melt. A small quantity imparts a violet colour to borax in the outer flame, and a smalt-blue colour in the inner flame.

$(\dot{\mathrm{Co}},\dot{\mathrm{Cu}})\ddot{\mathrm{Mn}}^2\mathrm{H}^4$.

Analysis of asbolane from Kamsdorf by Rammelsberg:—

Protoxide of manganese	40·05
Oxygen	9·47
Oxide of cobalt	19·45
Oxide of copper	4·35
Red oxide of iron	4·56
Barytes	0·50
Potash	0·37
Water	21·24

Occurs massive, mammillary, botryoidal and pulverulent, investing other minerals.

Is found at Kamsdorf, Saalfeld, Glücksbrum in Thuringia; Bieber and Riechelsdorf in Hessia; Wittichen in the Black Forest; Rengersdorf in Lusatia; in the mines of Mauknerötz and Geyer near Brixlegg in Tyrol; Nertschinsk in Siberia; in sandstone with copper pyrites at Alderley Edge in Cheshire; of a blue colour, investing fissures in slate clay in the peninsula of Howth near Dublin.

154. PSILOMELANE.—Psilomelane; Beudant. Untheilbares Mangan-Erz; Mohs. Schwarzbraunstein; Hausmann. Psilomelan; Haidinger.

Amorphous. Fracture even...flat conchoidal. Opaque. Lustre metallic, imperfect. Blueish-black, greyish-black...dark steel-grey. Streak brownish-black, shining. Brittle. H = 5·0 ...6·0. G = 3·7...4·4. Is a good conductor of electricity.

In the matrass yields water. Its reactions before the blowpipe are the same as those of manganite. In powder soluble in hydrochloric acid with an abundant evolution of chlorine. In powder imparts a red colour to concentrated sulphuric acid. After ignition, the potash which some varieties contain may be dissolved out by water.

Analyses of psilomelane *a* from Schneeberg, *b* from Romanèche, both by Turner, *c* from Baireuth by Fuchs, *d* from Horhausen by Rammelsberg, *e* from Ilmenau by Scheffler:—

	a	*b*	*c*	*d*	*e*
Red oxide of manganese $\dot{\mathrm{Mn}}\dddot{\overline{\mathrm{Mn}}}$	69·80	70·97	81·8	81·36	83·3
Oxygen	7·36	7·26	9·5	9·18	9·8
Barytes	16·36	16·69	—	—	5·8
Potash	—	—	4·5	3·04	—
Water	6·22	4·13	4·2	3·39	4·3
Silica	0·26	0·95	—	0·54	1·7
Black oxide of copper	—	—	—	0·96	—

	a	*b*	*c*	*d*	*e*
Red oxide of iron	—	—	—	1·43	0·3
Lime	—	—	—	0·38	1·8
Soda and magnesia	—	—	—	0·32	—
Alumina	—	—	—	—	2·1

Some varieties are nearly or quite anhydrous, as appears from the following analyses of psilomelane from Ilmenau *f* by Clausbruch, from Gy *g* by Ebelmen, from near Heidelberg *h* by Rammelsberg:—

	f	*g*	*h*
Protoxide of manganese	77·23	70·60	70·17
Oxygen	15·82	14·18	15·16
Potash	5·29	4·05	2·62
Lime	0·91	—	0·60
Magnesia	—	1·05	0·21
Barytes	0·12	6·55	8·08
Black oxide of copper	0·40	—	0·30
Red oxide of iron	—	0·77	—
Oxide of cobalt	—	—	0·54
Silica	0·52	0·60	0·90
Water	—	1·67	1·43

Occurs in botryoidal, reniform and stalactitic masses, also compact and disseminated. It is probably a mixture of different minerals.

Occurs in beds of pyrolusite and manganite, in veins in porphyry and in beds of chalybite and hydrous iron oxides; also in newer formations, especially in the new red sandstone. Is found at Mariaspring near Göttingen, in the Harz at Wurzelnberg in the Herzberg forests, near Braunlage, in the beds of iron ore of Elbingerode and Neuwerk, near Ilefeld, in Thuringia near Ilmenau, Eglersburg, Brotterode and Schmalkalden, in Saxony near Schneeberg, Johann-Georgenstadt and Ehrenfriedersdorf, in Stiria at Vordernberg in clefts in decomposed chalybite, Hollerter Zug in Siegen, Naila and Arzberg in Baireuth, in many parts of the Black Forest in veins in granite and new red sandstone, at Bieber in Hessia, near Siegen, at Kupferberg and Konradswaldau in Silesia, Schwarzthal and Ronsberg in Bohemia, Jessenitz in Moravia, Rhonitz in Hungary, Arschitz in Bukownia, Romanèche and other places in France, Christiansand in Norway, Devonshire, Cornwall, Monkton in Vermont in North America.

155. SASSOLINE.—Native boracic acid; Phillips. Acide boracique; Hauy. Prismatische Borax-Säure; Mohs. Sassolin; Hausmann, Haidinger.

Anorthic. 110,$\bar{1}$10 = 61° 30′; 100,110 = 59° 0′; $\bar{1}$11,$\bar{1}$10 = 47° 3′; 001,$\bar{1}$10 = 48° 0′; 001,110 = 80° 30′.

a 100, *c* 001, *y* 101, *x* $\bar{1}$01, *m* 110, *t* $\bar{1}$10, *v* 111, *r* $\bar{1}$11, *s* 1$\bar{1}$1, *u* $\bar{1}\bar{1}$1.

ma	59°	0′
mt	61	30
ta′	59	30
ya	51	21
ca	75	42
xa	106	10
vm	39	27
cm	80	33
um	131	25
rt	47	3
ct	95	3
st	137	55

FIG. 302.

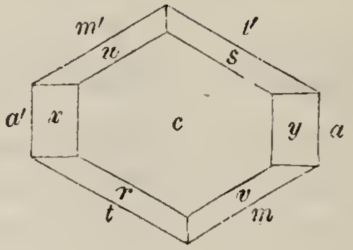
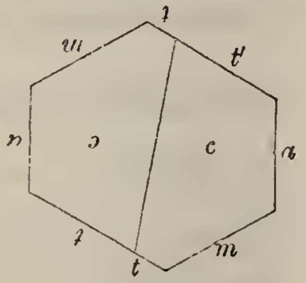


FIG. 303.



Combinations. *camt*, *camtvrsu*. Twins. Twin axis, the axis of the zone *amt*. ɔc = 29° 2′. Cleavage. *c*, very perfect and easily obtained. Transparent...translucent. Lustre pearly. The optic axes seen through the faces *c* appear to make with each other an angle of about 8°. Colourless, white, greyish-white, yellowish-white. Streak white. H = 1. G = 1·48.

Unctuous to the touch. Taste faintly acid and bitter. In the matrass yields water. Exposed to the flame of a lamp intumesces, and melts into a transparent bead, which on being rubbed, without being isolated, acquires resinous electricity. Imparts a green colour to the blowpipe flame. Soluble in 26 parts of water at 19° C, and in 3 parts of boiling water. Soluble in alcohol. The solution burns with a green flame.

$\overset{\cdots}{\mathrm{B}}\mathrm{o}\dot{\mathrm{H}}^3$, boracic acid 56·38, water 43·62.

In crystalline scales and crusts, granular and stalactitic.

Is found mixed with sulphur in crevices in the islands of Vulcano and Stromboli, and appears to have been produced by sublimation along with the vapour of water; also in solution in the water of hot springs in the neighbourhood of Sasso in Tuscany.

SILICATES.

156. STAUROLITE.—Staurolite; Phillips. Staurotide; Hauy. Prismatoidischer Granat; Mohs. Staurolith; Hausmann, Haidinger.

Prismatic. 011,010 = 34° 38; 101,001 = 34° 26′; 110,100 = 64° 40′.

a 100, *c* 001, *r* 011, *m* 110, *x* 302 twin-face, *z* 322 twin-face. *x* truncates the edge *ac*; *z* truncates the solid angle *cma*.

rc	55° 22′	*ma*	64° 40′	*zc*	60° 37′
rr′	110 44	*mm′*	50 40	*za*	59 42
xc	45 48	*mc*	90 0		

FIG. 304.

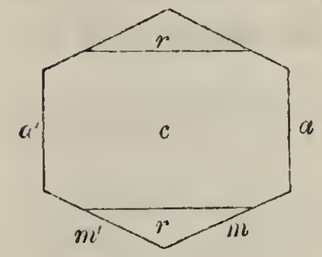


FIG. 305.

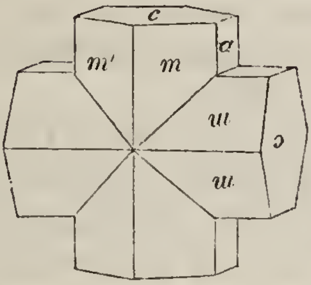
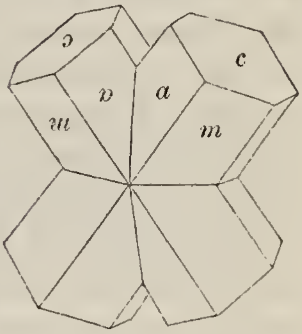


FIG. 306.



Combinations. *cm*, *cma*, *crma*. Twins. 1. Twin-face *x*. (fig. 305.) *cɔ* = 91° 36′. 2. Twin-face *z*. (fig. 306.) *cɔ* = 58° 46′, *aɐ* = — 60° 36′. The faces *c* sometimes rough. Cleavage. *a* perfect, but interrusted; *m* traces. Fracture conchoidal...uneven. Translucent...translucent on the edges. Lustre vitreous, inclining to resinous. For red rays in a plane parallel to *c*, and polarized in that plane, μ = 1·7526. The optic axes make angles of 42° 30′ with a normal to *c*, in a plane perpendicular to the edge *ac*. Reddish-brown...blackish-brown. Streak white. H = 7·0...7·5. G = 3·52...3·79.

Nearly infusible before the blowpipe. In borax melts with difficulty into a glass coloured green by iron. Soluble with very great difficulty in salt of phosphorus into a colourless opalescent glass. With soda melts with effervescence into a yellow slag. Partially decomposed by sulphuric acid either before or after ignition.

Analyses of staurolite *a*, *b* from Airolo, G = 3·66...3·73, *c*, *d* from Bretagne, G = 3·527...3·529, *e*, *f* from Polewskoi in the Ural, G = 3·547...3·588, all by Jacobson:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	33·45	32·99	39·19	40·35	38·68	38·33
Alumina	47·23	47·92	44·87	44·22	47·43	45·97
Red oxide of iron .	16·51	16·65	15·09	15·77	15·06	14·60
Ox. mangan. . .	—	—	0·17	0·10	—	—
Magnesia	1·99	1·66	0·32	—	2·44	2·47

Analyses of staurolite *g*, *h*, *k*, *l* from St. Gotthardt, G = 3·737 in fragments, G = 3·744 in powder, by Jacobson, *m* by Marignac:—

	g	h	k	l	m
Silica	30·91	29·72	29·13	30·31	28·47
Alumina	48·68	54·72	52·01	46·80	53·34
Red oxide of iron . . .	15·37	15·69	17·58	18·08	17·41
Protoxide of manganese .	1·19	—	lime	0 13	0·31
Magnesia	1·33	1·85	1·28	2·16	0·72

The composition of staurolite from Airolo is represented by $\dddot{\bar{R}}\ddot{\bar{S}}i$, where $\dddot{\bar{R}}$ is $\dddot{A}l$ and $\dddot{\bar{F}}e$. In staurolite from St. Gotthardt the bases contain about twice as much oxygen as the silica. In the varieties from Bretagne and the Ural the oxygen of the bases is $\frac{5}{4}$ of that of the silica.

In imbedded crystals in mica slate, talc slate, clay slate, rarely in gneiss, with garnet, kyanite, tourmaline.

Is found near Prato on St. Gotthardt, and on the Greiner in the Zillerthal, often attached to crystals of kyanite so that a face of one crystal is in contact with a face of the other, and their edges parallel; at Sebes in Transylvania, near Petersdorf and Goldenstein in Moravia, St. Jago di Compostella in Spain, in the neighbourhood of Oporto, in mica slate and isolated crystals at Quimper and Laminé in the department of Finisterre, Hières in the department of Var, in some of the Hebrides, in Aberdeenshire, Syra in the Ural, in the mica slate of New England.

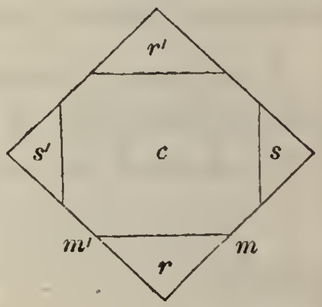
157. ANDALUSITE.—Andalusite; Phillips. Andalousite; Hauy. Andalusit; Hausmann, Haidinger.

Prismatic. 011,010 = 54° 34′; 101,001 = 35° 5′; 110,100 = 45° 22′.

a 100, *b* 010, *c* 001, *r* 011, *s* 101, *m* 110, *k* 120.

FIG. 307.

rc	35°	26′	*ka*	63°	44′
bc	90	0	*ba*	90	0
sc	35	5	*rr′*	70	54
ac	90	0	*ss′*	70	10
ma	45	22	*mm′*	89	16



Combinations. *cm*, *sm*, *csm*, *csrm*, *scmb*, *mcrsk*. Surface uneven and rough, seldom smooth, usually covered with films of mica. Cleavage. *m* more or less distinct; *b* imperfect; *s* and *a* traces. Fracture uneven, splintery, flat conchoidal. Transparent...translucent on the edges. Lustre vitreous. For a red ray in a plane parallel to *c*, and polarized in that plane $\mu = 1{\cdot}624$. The optic axes lie in a plane perpendicular to the faces *r*, *c*, *r′*, and make angles of 46° 13′·5 with a normal to *c*. Pearl-grey, flesh-red, peach-blossom-red...violet...reddish-brown; seldom green. In a variety from the Brazils rays transmitted through the crystal in planes parallel to *a*, *b*, *c*, and polarized in those planes, are oil-green, olive-green and red respectively. Streak white. H = 7·5. G = 3·1...3·2.

Infusible before the blowpipe. Soluble with extreme difficulty in borax, forming a clear glass. In powder becomes blue with solution of cobalt. Very slightly attacked by acids.

$\dddot{Al}\ddot{Si}$, silica 37·52, alumina 62·48.

Analyses of andalusite *a* from Herzogau by Bucholz, *b* of peach-blossom-red andalusite from Munzig in the Triebischthal, G = 3·152, by Kersten, *c* from Fahlun by Svanberg, *d* from Lisens by Bunsen, *e* from Lisens, G = 3·154, by A. Erdmann:—

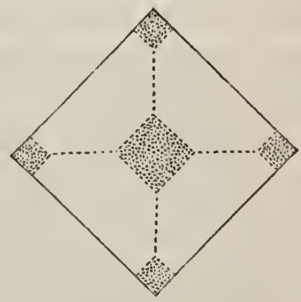
	a	*b*	*c*	*d*	*e*
Silica	36·5	37·51	37·65	40·17	39·99
Alumina . . .	60·5	60·01	59·87	58·62	58·60
Red oxide of iron .	4·0	1·49	1·87	—	0·72
Magnesia . . .	—	0·46	0·38	($\ddot{Mn}$ 0·51	0·83)
Lime	—	0·48	0·58	0·28	—

Andalusite decomposes very readily, being frequently converted into a steatitic substance containing kyanite, or into a substance like kaolin, for which H = 3, G = 2·70.

In attached and imbedded crystals, in granite, gneiss, mica slate.

Is found near Toledo, in the Sierra Morena and in Aragon; Lisens in the Tyrol, Arber near Bodenmais, Lahmerwinkel and Herzogau in Bavaria, Kaplitz and Albenreuth near Iglau in Bohemia, Goldenstein and Winkelsdorf in Moravia, Landeck and Freiwaldau in Silesia, Bräunsdorf and Penig in Saxony, at Forez in France, near Schaitansk in Siberia, in the alluvium of Gupiara in Minas Novas in the Brazils, at Botrifney in Banffshire in gneiss, in mica slate at Killiney in Ireland, Lichfield in Connecticut, and Westford in Massachusetts.

FIG. 308.



Chiastolite appears to be a variety of andalusite having prisms of a darker substance in the centre, and sometimes in each angle, connected by thin plates of the same. The dark portions are either the slate in which the crystals are imbedded, or discolorations produced by carbonaceous matter, which disappear on igniting the crystal. H = 5·0 ...5·5. G = 2·9...2·95.

Analysis of chiastolite *a* from Lancaster by Bunsen, *b* by Jackson:—

	a		*b*
Silica	39·09		33·0
Alumina	58·56		61·0
Oxide of manganese	0·53	$\dddot{\bar{\mathrm{Fe}}}$	4·0
Lime	0·21		—
Volatile matter	0·99	$\dot{\mathrm{H}}$	1·5

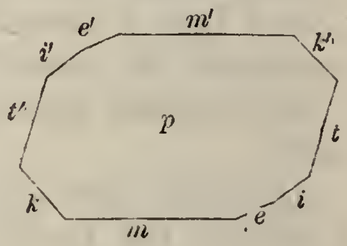
Chiastolite occurs imbedded in clay slate near Barèges, in the valleys of Luchon and Gistain in the Pyrenees, Serra de Marão in Portugal, St. Jago di Compostella, near Santa Elena in the Sierra Morena in Spain, St. Brieux in Bas Bretagne, Gefrees in the Fichtelgebirge, Greifenhagen in the Harz, the Wolfscrag near Keswick in Cumberland, Agnavanagh in Wicklow, in dolomite on the Simplon, in grey limestone at Couledoux in La Haute Garonne, at Sterling and Lancaster in Massachusetts, Siberia, Mexico.

158. KYANITE.—Kyanite; Phillips. Disthène; Hauy. Prismatischer Disthen-Spath; Mohs. Disthen; Hausmann. Kyanit; Haidinger.

Anorthic.

em	20°	45′
im	34	19
tm	73	44
km	48	37
pm	79	10
pt	86	45

FIG. 309.



Combinations. *pmt..k.i.e.* The faces *m*, *t* are sometimes striated parallel to their intersections with each other. Twins. 1. Twin-face *m*. 2. Twin-axis the axis of the zone *mt*. Pairs of crystals occur also united by the faces *m*, so that the faces *p* of the two individuals, and the axes of the zones *mt* are parallel, the faces *t* forming a re-entering angle. Cleavage. *m* very perfect, *t* less perfect, *p* least perfect. Fracture uneven. Transparent...translucent. Lustre, pearly on *m*, vitreous on the other faces. Colourless, white, passing into blue, green, and sometimes grey. Stripes of blue occur frequently on a lighter ground. On looking through a blue crystal in a direction parallel to the edge *mp*, it is of a deep blue colour when the light is polarized in a plane perpendicular to *m*, and colourless when the light is polarized in a plane parallel to *m*. In a direction nearly perpendicular to *m*, the colour is lighter or darker according as the light is polarized in planes parallel or perpendicular to the edge *mt*. Streak white. Brittle. H = 5·0 on the faces *m*, above 6·0 on the other faces and on the angles and edges. G = 3·58...3·62.

Perfectly infusible before the blowpipe. The coloured varieties become white. With borax melts with difficulty, but completely, into a transparent colourless glass. With salt of phosphorus leaves an opaque skeleton of silica. With a little soda melts partially; with more soda intumesces and becomes infusible. Moistened with solution of cobalt and strongly heated becomes blue. Is not acted upon by acids.

$\overset{\dots}{\mathrm{Al}}\ddot{\mathrm{Si}}$, silica 37·52, alumina 62·48.

Analyses of kyanite *a*, *b* from St. Gotthardt by Arfvedson, *c* from St. Gotthardt by Rosales, *d* from St. Gotthardt, G = 3·6, by Marignac, *e* from Röraas by Arfvedson, *f* from the Tyrol, G = 3·661, by A. Erdmann, *g* from the Greiner, G = 3·678, by Jacobson :—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Silica	34·33	36·9	36·67	36·60	36·4	37·36	37·30
Alumina	64·89	64·7	63·11	62·66	63·8	62·09	62·60
Red ox. iron .	—	—	1·19	0·84	—	0·71	1·08

In imbedded crystals, in mica slate, talc slate, gneiss, granite, dolomite, marble, with staurolite, which is frequently attached to or imbedded in the crystal of kyanite, with the face *a*, and the edge *am*, of the staurolite parallel to the face *m*, and edge *mt*, of the kyanite; in columnar or fibrous masses; pseudomorphous after andalusite.

Analyses of a brown columnar variety (sillimanite) from Pettypang near Saybrook in Connecticut *h* by Staaff, *i* by B. Silliman, *k* of a fibrous variety (bucholzite or fibrolite) from Chester in Pennsylvania by A. Erdmann, *l* from Chester, *m* from Brandywine Springs, *n* of Bournon's fibrolite, all by B. Silliman :—

	h	*i*	*k*	*l*	*m*	*n*
Silica	37·36	37·65	40·08	34·31	36·16	36·31
Alumina	58·62	62·41	58·88	64·43	63·53	62·42
Red oxide of iron .	2·17	—	0·74	—	—	0·70
Magnesia . . .	0·40	—	—	0·52	—	—

Is found in many places on St. Gotthardt, in mica slate, on the Greiner and at Pfitsch in the Tyrol, on the Bacher in Styria, on the Sau Alp in Carinthia, Gängerhäusel near Petschau in Bohemia; Bodenmais, Hof and Aschaffenburg in Bavaria, in the mining districts of Saxony, near Sebes in Transylvania, Langenlois near Krems in Austria, Bernstein in Moravia, the island of Syra, in many places in the Ural, Botriphny in

Banffshire, near Banchory in Aberdeenshire, Zetland, Lichfield in Connecticut, Chesterfield and Russell in Massachusetts and many other places in the United States, in the Serro do Conçeiçao and Passagem in Minas Geraes in the Brazils, in the Himalaya mountains. Sillimanite occurs in slender prisms at Chester and Yantic in Connecticut, Yorktown in New York. Fibrolite is found with corundum in the Carnatic and in China, Lisens and Faltigl in the Tyrol, Moravia, Bohemia, and North America.

159. BAMLITE.—Bamlite; Dufrénoy. Bamlit; Hausmann, Haidinger.

Fracture uneven and splintery. Translucent. Lustre vitreous; silky in the columnar masses. White, sometimes inclining to green. H = 6·5. G = 2·984.

Before the blowpipe slowly soluble in borax forming a colourless glass. With solution of cobalt becomes blue.

Analysis by Erdmann:—

Silica	56·90
Alumina	40·73
Red oxide of iron . . .	1·04
Lime	1·04
Fluorine	trace

Is found in long slender prisms and crystalline masses, with quartz in gneiss, at Bräkke not far from Brevig in the parish of Bamle in Norway.

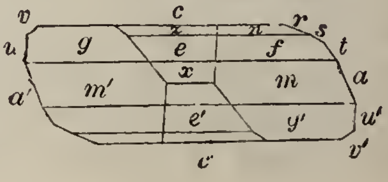
160. WOLLASTONITE.—Tabular spar; Phillips. Wollastonite; Hauy. Prismatischer Augit-Spath; Mohs. Wollastonit; Hausmann, Haidinger.

Oblique. 101,100=32° 4′; 111,010=59° 24′·4; 101,001=37° 44′.

a 100, *c* 001, *r* 205, *s* 203, *t* 201, *u* $\bar{2}01$, *v* $\bar{2}03$, *z* 023, *e* 011, *x* 021, *m* 110, *n* 111, *f* 221, *g* $\bar{2}21$.

rc	20°	30′	*nc*	47°	6′	*ff′*	106°	45′
sc	29	41	*fc*	59	10	*mm′*	95	35
tc	50	18	*mc*	75	11	*gg′*	92	14
ac	69	48	*gc*	93	52			
uc	95	23	*gu*	43	53			
vc	135	32	*ft*	36	37			
zc	34	52	*zz′*	110	16			
ec	46	16	*ee′*	87	28			
xc	64	26	*xx′*	51	8			
ma	42	12	*nn′*	118	49			

FIG. 310.



Twins. Twin-face *c*. Cleavage. *c*, *t*, *u*, *a*, *a* being the brightest. Fracture uneven. Semi-transparent...translucent on the edges. Lustre vitreous, inclining to pearly on the cleavages. White, passing into grey, yellow, red, and brown. Streak white. Rather brittle. H = 5·0. G = 2·8...2·9.

Melts with difficulty before the blowpipe into a semi-transparent glass. Is soluble in borax and salt of phosphorus, leaving a skeleton of silica. Is completely decomposed by hydrochloric acid, leaving a jelly of silica.

$\dot{\text{Ca}}\ddot{\text{Si}}$, silica 52·37, lime 47·63.

Analyses of wollastonite *a* from Skräbböle in Finland by Bonsdorff, *b* from Perhoniemi in Finland by H. Rose, *c* from Cziklowa by Stromeyer, *d* by Beudant, *e* from Wilsborough on Lake Champlain by Seybert, *f* by Vanuxem :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	52·58	52·19	51·45	53·1	51·0	51·67
Lime	44·45	46·93	47·41	45·1	46·0	47·00
Magnesia . . .	0·68	($\bar{\cancel{\text{Mn}}}$	0 26)	1·8	trace	—
Red oxide of iron	0·13	($\dot{\text{Fe}}$	0·40)	—	1·3	1·35
Water	0·99	—	0·08	—	1·0	—

Analyses of wollastonite *g* from Capo di Bove by v. Kobell, *h* from Diana in New York by Beck, *i* from Pargas by Palander, *k* from Göckum in Upland by Weidling, *l* from Harzburg by Rammelsberg, *m* from Greenville in Upper Canada by Bunce :—

	g	*h*	*i*	*k*	*l*	*m*
Silica	51·50	51·90	50·60	52·16	53·01	53·05
Lime	45·45	47·55	47·21	45·04	44·91	45·74
Magnesia	0·55	$\bar{\text{Al}}\bar{\cancel{\text{Fe}}}$	0·14	0·90	1·04	—
Red oxide of iron .	—	0·25	—	0·87	$\dot{\text{Fe}}$	1·20
Water	2·00	—	($\bar{\cancel{\text{Mn}}}$	0·34)	1·59	—

Occurs in attached and imbedded crystals, lamellar, granular or columnar masses, usually in beds of granular limestone in the older slate rocks, with garnet, pyroxene and amphibole.

Is found at Cziklowa and Orawitza in the Banat, Skräbböle, Pargas, and Porhoniemi in Finland, at Gökum in Sweden, crystallized in the Fossa Grande in matter ejected by Vesuvius, and at Capo di Bove near Rome in lava, at Greenville in Canada, in the United States, in Wilsborough in New York, Bucks County and Easton in Pennsylvania, in Hesse Darmstadt, Auerbach near Schwarzenberg in Saxony, in Ceylon with garnet in gneiss, in the castle rock of Edinburgh in trap. A cleavable substance resembling wollastonite in appearance and composition has been found in the slags of iron furnaces.

It has also been obtained by fusing in a crucible lime and silica in the required proportions.

In the Phil. Mag. for Sept. 1831, Mr. Brooke has given the form and angles of a mineral from Vesuvius which he received as wollastonite. This particular specimen has not been analyzed, but it resembles others received in this country under the same name. The fragment figured by W. Phillips as tabular spar was taken from a specimen stated on its ticket to be from Vermont, U. S. The supposed tabular spar is in large grains, and is accompanied by small grains of coccolite; but we do not find any notice in the American works on Mineralogy of such an association of minerals having been found in Vermont.

161. AUGITE.—Augite, Pyroxene; Phillips. Pyroxène; Hauy. Paratomer Augit-Spath; Mohs. Diopsid, Amianth, Malacolith, Augit; Hausmann. Augit; Haidinger.

Oblique. 101,100=49° 50′; 101,001=24° 19′·8; 111,010=65° 41′·7.

a 100, *b* 010, *c* 001, *e* 011, *z* 021, *x* 041, *p* $\bar{1}01$, *y* 101, *n* $\bar{1}02$, *q* $\bar{3}01$, *f* 310, *g* 210, *m* 110, *μ* 120, *i* 130, *s* $\bar{1}11$, *o* $\bar{2}21$, λ $\bar{3}31$, *u* 111, *d* 131, *v* 221, *ζ* $\bar{4}83$, *φ* 152.

ya	49°	50′	*mb*	43°	33′	*ζo*	16°	24′
ca	73	59	*gb*	62	15	*uc*	33	51
na	89	20	*fb*	70	40	*vc*	49	54
pa	105	24	*ab*	90	0	*mc*	79	3
qa	144	28	*λb*	44	4	*cλ′*	103	26
xb	23	42	*ob*	47	45	*co′*	114	28
zb	41	17	*sb*	60	16	*cs′*	137	49
eb	60	20	*db*	36	26	*mm′*	87	5
cb	90	0	*ub*	65	42	*oo′*	95	30
ib	17	35	*vb*	55	35	*ss′*	120	31
μb	25	25	*φb*	37	49	*zz′*	82	33

FIG. 311.

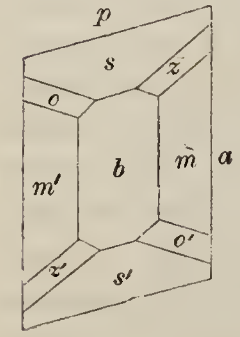


FIG. 312.

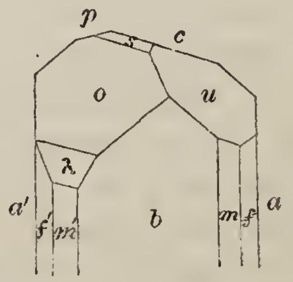


FIG. 313.

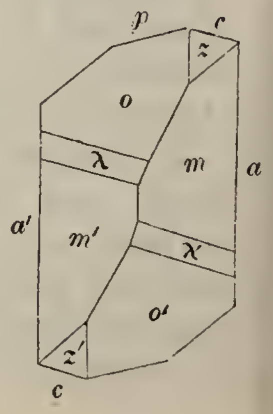
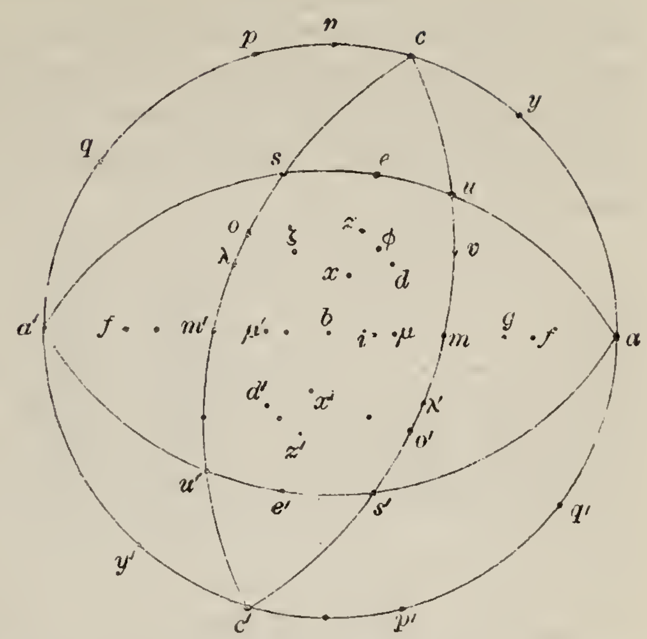


FIG. 314.



Combinations. *cm*, *cab*, *cabm*, *sma..p.o.z.b*, *nmab..c.p*,*om..c.s.p.z.λ.a*, *cpuoab..s.m.f*,*somab*. The faces *c*, *p* usually rough; *n*, curved; *a*, *b* striated parallel to their intersections with each other; *o*, striated parallel to their intersections with *s*. Twins. Twin-face *a*. Cleavage. *m*, tolerably perfect, but interrupted; *a*, *b* less distinct; *s*, occasionally. Planes of union, but not of true cleavage, occur frequently in some varieties parallel to *c*. Fracture conchoidal...uneven. Transparent...opaque. Lustre vitreous. For rays in a plane parallel to *b*, and polarized in that plane, $\mu = 1{\cdot}680$. The optic axes lie in a plane parallel to *b*. One makes angles of 80° 34′ and 6° 35′ with normals to *a* and *c* respectively; the other makes angles of 21° 38′ and 52° 21′ with normals to *a* and *c* respectively. Colourless, white, usually coloured, grey, green, black. Streak white...grey. Brittle. H = 5·0...6·0. G = 3·2...3·4.

Before the blowpipe melts into a white, grey, green or black glass. With borax and salt of phosphorus usually yields the reaction of iron. With solution of cobalt the white and colourless varieties become red. Is but slightly acted upon by acids.

$\dot{\mathrm{Ca}}\ddot{\mathrm{Si}} + \dot{\mathrm{R}}\ddot{\mathrm{Si}}$, where $\dot{\mathrm{R}}$ consists essentially of $\dot{\mathrm{Mg}}$ and $\dot{\mathrm{Fe}}$.

Analyses of the grey and green transparent varieties called diopside *a* from the Fassathal by Wackenroder, *b* from Orijerfvi by H. Rose, *c* from Langbanshytta in Wärmland by H. Rose, *d* from Tammare in Finland by v. Bonsdorff, *e* from Achmatowsk, G = 3·28, by Hermann, *f* from the Brazils by Kussin :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	54·15	54·64	55·32	54·83	53·97	55·61
Lime	24·74	24·94	23·01	24·76	25·60	25·11
Magnesia . . .	18·22	18·00	16·99	18·55	17·86	17·82
Protox. iron . . .	2·50	1·08	($\ddot{\mathrm{Fe}}$ 2·16)	0·99	2·00	1·20
Protox. mang. . .	0·18	2·00	1·59	0·32	0·57	—
Alumina	0·20	—	—	0·28	—	—

Analyses of the translucent green and brown varieties called malacolite or sahlite *g* from Sahla, *h*, *i* from Björmyresweden in Dalecarlia, all by H. Rose, *k* from Langbanshytta, G = 3·27, by Reuterskföld, *l* from Nordmark by Funk, *m* of fibrous augite (amianthus) from Schwarzenstein in the Tyrol by Meitzendorf:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	54·86	54·08	54·55	53·56	52·18	55·87
Lime	23·57	23·47	20·21	23·86	22·00	17·76
Magnesia	16·49	11·49	15·25	16·27	7·06	20·33
Protoxide of iron . .	4·44	10·02	8·14	4·48	16·13	4·31
Protox. mang. . .	0·42	0·61	0·73	1·87	1·61	1·12
Alumina	0·21	—	0·14	0·25	0·42	—

Analyses of the dark green or black opaque varieties called augite *n* from Pargas in Finland by Nordenskiöld, *o* from the Rhöngebirge (mean of two), *p* from Gillenfelder Maar (mean of four), *q* from Zigolonberg in the Fassathal (mean of two), *r* from Ætna, *s* from Vesuvius, all by Kudernatsch:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	51·80	50·42	48·75	50·12	50·55	50·90
Alumina	6·56	6·57	5·70	4·20	4·85	5·37
Lime	19·07	18·78	23·01	20·05	22·29	22·96
Magnesia	12·01	16·31	14·30	13·70	13·01	14·43
Protoxide of iron . .	6·92	7·40	7·55	11·60	7·96	6·25
Water	1·02	—	—	—	—	—

Analyses of the black variety (hedenbergite) *t* from Tunaberg, *u* from Taberg, both by H. Rose, *v* from Arendal by Wolff, *w* from the island of Pico, G = 3·174, by Hochstetter, *x* of asbestiform augite by Gruner, *y* of augite, G = 3·380, from a mixture of crystals of augite and amphibole imbedded in one another in the basaltic tufa of Härtlingen, by Rammelsberg:—

	t	*u*	*v*	*w*	*x*	*y*
Silica	49·01	53·36	47·78	50·40	43·9	47·52
Alumina	—	—	—	2·99	1·9	8·13
Lime	20·87	22·19	22·95	21·10	0·5	18·25
Magnesia	2·98	4·99	—	2·40	1·1	12·76
Protox. iron	26·08	17·38	27·01	22·00	52·2	13·02
Protox. mang. . . .	—	0·09	(water	0·30)	—	0·40

In imbedded and attached crystals and columnar, fibrous and granular masses.

Augite is found in imbedded crystals in basalt, lava and dolerite at Boreslau, Wolfsberg near Cernossin in Bohemia, the Rhöngebirge, Vogelsgebirge, the Kaiserstuhl in the Breisgau, Auvergne and Velay in France, Vesuvius, Teneriffe, Bourbon, Scotland; in granular limestone at Pargas in Finland and several places in North America; in the meteoric stones which fell at Stannern in Moravia. It is sometimes found in the slags of iron furnaces, and has been obtained by fusing silica, lime and magnesia in proper proportions in a crucible, and permitting the mass to cool very slowly. By exposure to the atmosphere the variety called augite undergoes decomposition, and is converted into an earthy or steatitic substance.

The transparent grey and green variety called diopside is found on the Mussa Alp in Piedmont and Schwarzenstein in the Tyrol with garnet and chlorite, in many parts of the Swiss and Italian Alps, at Reichenstein in Silesia, Tjotten, Modum in Norway, Malsjö and many other places in Sweden, Tammare in the parish of Hwittis, Orijerfvi in Finland, Achmatowsk in the Ural, Lichfield in Connecticut, Bolton in Massachusetts and several other parts of the United States. Malacolite or sahlite is found in beds of iron and copper pyrites, magnetite, and hematite at Arendal in Norway, Fahlun, Norberg, Nya Kopparberg, Langbanshytta, Persberg, Philipstad, and in veins with galena at Sahla in Sweden, near Schwarzenberg in Saxony, Monzoni in the Tyrol in granular limestone, at the foot of Vesuvius in matter ejected from the crater, well crystallized in the valley of Brosso in Piedmont, Fassathal in the Tyrol, Buön near Arendal, the Age mine and Taberg near Philipstad in Sweden, the sources of the Sljudenka S.W. of the Baikal, Monroe and other places in New York. In the grass-green smaragdite from the Bacher, augite and amphibole occur in alternate layers, one of the cleavages of the amphibole being parallel to the face *a* of the augite, and the intersection of the cleavages parallel to the edge *ab*.

162. HYPERSTHENE.—Hypersthene; Phillips, Hauy. Prismatoidischer Schiller-Spath; Mohs. Hypersthen; Hausmann, Haidinger.

Oblique. Isomorphous with augite.

a 100, *b* 010, *p* $\bar{1}01$, *m* 110.

mb	43°	15′
ab	90	0
ma	46	45
mm′	86	30

Cleavage. *m*, distinct, but interrupted; *a*, perfect; *b*, imperfect. Fracture uneven. Opaque, in some varieties translucent on the edges. Lustre pearly on the planes of most perfect cleavage; on the other faces vitreous; on surfaces of fracture inclining to resinous. Greyish-black, greenish-black; in many varieties almost copper-red on the planes of perfect cleavage. Streak greenish-grey. Very tough. H = 6·0. G = 3·39.

Before the blowpipe melts more or less readily into a greenish-black glass which is frequently magnetic. Readily soluble in borax, forming a greenish glass. Is not acted upon by acids.

$\dot{R}\ddot{Si}$, where $\dot{R}$ is principally magnesia and protoxide of iron, usually with small quantities of lime and protoxide of manganese.

Analyses of hypersthene *a* from the island of St. Paul, *b* from the island of Skye, both by Muir, *c* from Labrador by Damour:—

	a	*b*	*c*
Silica	46·11	51·35	51·36
Alumina	4·07	—	0·37
Magnesia	25·87	11·09	21·31
Lime	5·38	1·84	3·09
Protoxide of iron	12·70	33·92	21·27
Protoxide of manganese	5·29	—	1·32
Water	0·48	0·50	—

In crystals and crystalline, granular masses.

Is found in the island of St. Paul on the Labrador coast in rolled masses and as a constituent of a greenstone rock, Greenland, in many parts of Norway in hypersthene rock, in the island of Skye, Penig in Saxony, Ronsberg in Bohemia, Monzoni in the Tyrol, Elfdalen in Sweden, Neurode in Silesia, and in boulders in the neighbourhood of Berlin.

163. BRONZITE.—Bronzite; Phillips. Diallage (in part); Hauy. Hemiprismatischer Schiller-Spath; Mohs. Bronzit; Hausmann, Haidinger.

Oblique. Isomorphous with augite.

a 100, *b* 010, *c* 001, *m* 110, all cleavages.

mb	43°	0′
ab	90	0
mb	47	0
mm′	86	0

Cleavage. *a*, very perfect, usually rather curved; *m*, less distinct; *c*, *b* traces. Translucent...translucent on the edges. Lustre, on *a* pearly or silky inclining to metallic, on the other faces resinous or vitreous. Clove-brown...pinchbeck-brown, sometimes greenish or yellowish. Streak white. Slightly brittle. H = 5·0...6·0. G = 3·2...3·6.

Melts with great difficulty before the blowpipe. Is not decomposed by acids.

$\dot{R}\ddot{Si}$, where $\dot{R}$ is magnesia and protoxide of iron.

Analyses of bronzite *a* from the Stempel near Marburg, *b* from Ultenthal in the Tyrol, both by Köhler, *c* from Ultenthal, *d* from Stiria, both by Regnault:—

	a	*b*	*c*	*d*
Silica	57·19	56·81	55·84	56·41
Alumina	0·70	2·07	1·09	—
Magnesia	32·67	29·68	30·37	31·50
Lime	1·30	2·19	—	—
Protoxide of iron	7·46	8·46	10·78	6·56
Protoxide of manganese . .	0·35	0·62	—	3·30
Water	0·63	0·22	1·80	2·38

In imperfect imbedded crystals; massive in granular aggregations.

Is found in serpentine on the Gulsen in Stiria, near Kupferberg in Bayreuth, Lettowitz and Goldenstein in Moravia, the Bacher mountain in Lower Stiria, and the Lizard in Cornwall, on the Seefeld Alp in Ultenthal in the Tyrol; in basalt on the Stempel near Marburg, and on the Alpstein near Sontra in Hessia. It is said to occur also at Volpersdorf and Zobtenberg in Silesia, and in the Sierra Nevada in Spain.

164. DIALLAGE.—Diallage (in part); Phillips, Hauy. Prismatischer Schiller-Spath (in part); Mohs. Diallag; Hausmann, Haidinger.

Oblique. Supposed to be isomorphous with augite.

Cleavage in two directions making right angles with each other; one perfect, the other imperfect; traces of cleavage in other directions. Fracture uneven, splintery. Opaque; in very thin flakes translucent. Lustre on the plane of perfect cleavage pearly or silky, inclining to metallic. Grey, brownish-grey, brownish-green, sometimes light pinchbeck-brown. Streak white. H = 4·0. G = 3·2...3·3.

Before the blowpipe melts readily into a grey and green enamel. Is not acted upon by acids.

Analyses of diallage *a* from the Baste (mean of two), *b* from Salzburg, *c* from Prato in Tuscany, all by Köhler, *d* from Traunstein, *e* from Piedmont, both by Regnault, *f* from Grossarl in Salzburg by v. Kobell:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	52·89	51·34	53·20	51·25	50·05	50·20
Alumina	2·70	4·39	2·47	3·98	2·58	3·80
Magnesia	17·68	15·69	14·91	22·88	17·24	16·40
Lime	17·40	18·28	19·09	11·18	15·63	20·26
Protoxide of iron } Protox. mang. }	8·41	8·23	8·67	6·75	11·98	8·40
			0·38	—	—	traces
Water	1·06	2·11	1·77	3·32	2·13	—

In imperfect crystals; massive having a crystalline structure; granular; lamellar.

Is found with amphibole in euphotide in the Harzburg Forest in the Harz, and la Prese in the Valteline; in Silesia, in the Apennines, in the Ural.

Diaclasite appears to be a variety of diallage from the euphotide of the Harzburg Forest, and the gneiss of the Guadarrama mountains in Spain, in crystals showing the faces *a*, *b*, *m*, *s*. Between bronze and brass-yellow, more or less inclining to green. Streak greenish-grey. H = 3·5...4·0. G = 3·054. According to Köhler, diaclasite from the Harzburg Forest contains:—silica 53·74, alumina 1·34, magnesia 25·09, lime 4·73, protoxide of iron 11·51, protoxide of manganese 0·23, water 3·76.

165. RHODONITE. — Siliciferous oxide of manganese; Phillips. Manganèse oxidé silicifère; Hauy. Diatomer Augit-Spath; Mohs. Rhodonit; Hausmann, Haidinger.

Oblique. Isomorphous with augite.

a 100, *b* 010, *c* 001, *m* 110, all cleavages.

ac	74°	0′
bc	90	0
ma	43	33
ba	90	0
mm′	87	6

Cleavage. *a*, perfect; *b*, less perfect; *m*, imperfect. Fracture uneven. Translucent...translucent on the edges. Lustre vitreous, inclining to pearly on the cleavages *m*. Rose-red, peach-blossom-red, brown, spotted with green. Streak reddish-white. H = 5·0...5·5. G = 3·61...3·65.

Before the blowpipe on charcoal in the inner flame melts into a red semi-transparent glass, in the outer flame into a black globule. With borax and salt of phosphorus in the outer flame melts into a violet glass, the colour of which disappears in the inner flame. Is not decomposed by hydrochloric acid.

By exposure the manganese becomes more highly oxidized, and combines with water, forming a black crust.

$\dot{Mn}\ddot{Si}$, silica 46·41, protoxide of manganese 53·59, part of the $\dot{Mn}$ being replaced by $\dot{Fe}$, $\dot{Zc}$, $\dot{Ca}$, $\dot{Mg}$.

Analyses of rhodonite *a* from Langbanshytta by Berzelius, *b* from Algiers and *c* from St. Marcel in Piedmont by Ebelmen, *d* from Sterling in New Jersey by Hermann :—

	a	*b*	*c*	*d*
Silica	48·00	45·49	46·37	46·48
Protoxide of manganese . .	49·04	39·46	47·38	31·52
Protoxide of iron	—	6·42	—	7·23
Oxide of zinc	—	—	—	5·85
Lime	3·12	4·66	5·48	4·50
Magnesia	0·22	2·60	—	3·09
Loss by ignition	—	—	—	1·00

Is found in cleavable and compact masses, at Langbanshytta in Sweden, Schabrowa near Katharinenburg, Kapnick in Transylvania, Schebenholz near Elbingerode, and Oberstahlberg near Rübeland in the Harz, New Jersey, Piedmont, Algiers.

166. AMPHIBOLE.—Hornblende; Phillips. Amphibole; Hauy. Hemiprismatischer Augit-Spath; Mohs. Amphibol; Hausmann, Haidinger.

Oblique. 101,100 = 50° 35′; 111,010 = 77° 13′; 101,001 = 24° 27′.

a 100, *b* 010, *c* 001, *z* 021, *l* 101, *w* $\bar{1}01$, *t* $\bar{2}01$, *m* 110, *n* 310, *e* 130, *k* 111, *r* $\bar{1}11$, *v* 131, *i* $\bar{1}31$, *o* 221.

la	50°	35′	*mb*	62°	15′	*mc*	76°	48′
ca	75	2	*eb*	32	21	*co′*	121	29
wa	106	2	*mm′*	124	30	*cr′*	145	35
ta	130	6	*kb*	77	13	*rt*	28	31
tc	55	4	*vb*	55	46	*zt*	60	8
cb	90	0	*rb*	74	14	*vt*	81	21
zb	60	26	*ib*	49	45	*mt*	124	42
ab	90	0	*ob*	65	48			
nb	80	3	*kc*	27	24			

FIG. 315.

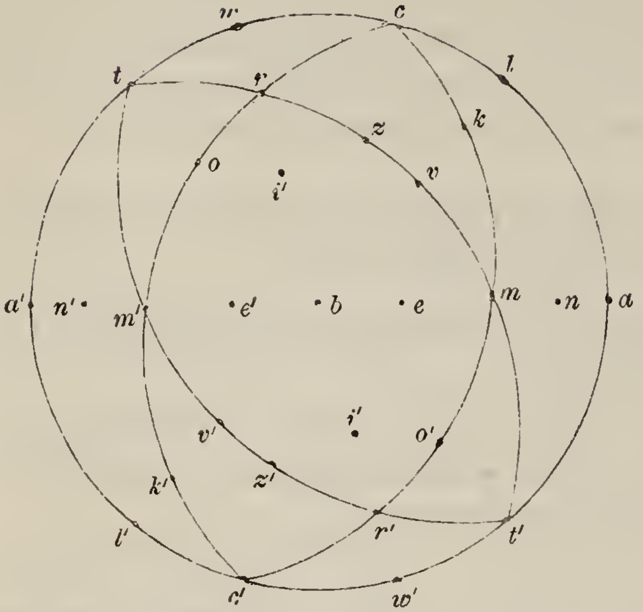


FIG. 316.

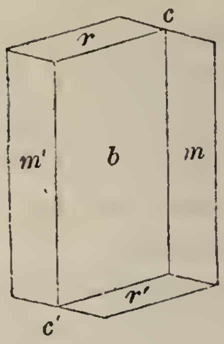
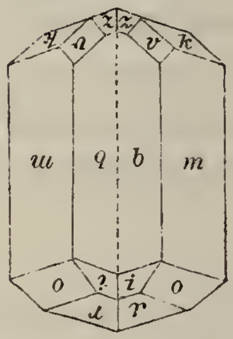


FIG. 317.



Combinations. *lm..c.a*, *crmb..aw*, *crzmb..k.v.i.o*, *ckrztovimeba*. Twins. Twin-face *a*. The faces *a*, *n*, *m*, *e*, *b* are sometimes striated parallel to their intersections with each other. The faces are frequently uneven and rounded. Cleavage. *m*, very perfect; *a*, *b* indistinct. Fracture imperfect conchoidal. Slightly translucent...opaque. Lustre vitreous, in the light coloured varieties inclining to pearly. Colourless, white, usually green of various shades, brown, yellow, grey, black. Streak greyish-white...brown. Brittle. H = 5·0...6·0. G = 2·90...3·40.

Before the blowpipe melts with intumescence into a grey, green or black bead. Its fusibility increases with the proportion of iron contained in it. Dissolves slowly in borax. The varieties which are rich in iron are slightly acted on by hydrochloric acid.

$3\dot{R}\ddot{S} + \dot{R}^2\ddot{S}^3$, where $\dot{R}$ is magnesia, lime and frequently protoxide of iron. The green and black varieties frequently contain a considerable quantity of alumina, amounting in some instances to 16 per cent., which appears to form an aluminate of magnesia or protoxide of iron capable of crystallizing with the silicates in all proportions.

Analyses of the white, grey and bright green varieties exhibiting the forms *b*, *m*, G = 2·93...3·04 (grammatite or tremolite), *a* from Fahlun, *b* from Gullsjö by v. Bonsdorff, *c* from Cziklowa by Beudant, of the green varieties having the forms *b*, *m*, *r*, G = 3·01…3·03 (actinote), *d* from Taberg by v. Bonsdorff, *e* from Pennsylvania by Seybert, of the brown columnar variety, G = 3·27…3·31 (anthophyllite) *f* from Kongsberg by Vopelius :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	60·10	59·75	59·5	59·75	56·33	56·74
Magnesia	24·31	25·00	26·8	21·10	24·00	24·35
Lime	12·73	14·11	12·3	14·25	10·67	—
Protoxide of iron . .	1·00	0·50	trace	3·95	4·30	13·94
Protox. mangan. . .	0·47	—	—	0·31	—	2·38
Alumina	0·42	trace	1·4	—	1·67	—
Hydrofluoric acid . .	0·83	0·94	—	0·76	—	—
Water	0·15	0·10	—	—	1·03	1·67

Analyses of fibrous amphibole (asbestus) *g* from the Tarentaise by v. Bonsdorff, *h* from Kuhnsdorf in the Voigtland by Rammelsberg, *i* from Taberg by Murray, *k* from Koruk in Greenland by Lappe, *l*, *m* from the sources of the Tschussowaja in the Ural by Heintze :—

	g	*h*	*i*	*k*	*l*	*m*
Silica	58·20	57·98	59·50	58·48	59·23	58·19
Magnesia	22·10	22·38	19·30	31·38	31·02	30·79
Lime	15·55	12·95	12·65	0·04	—	—
Protoxide of iron . .	3·08	6·32	8·60	9·22	8·27	7·93
Protox. mang. . . .	0·21	—	—	0·88	—	—
Alumina	0·14	0·58	—		0·19	0·18
Hydrofluoric acid .	0·66	loss by ignition			1·31	1·86

Analyses of black amphibole *n* from Slätmyran near Fahlun, *o* from the parish of Garpenberg, *p* from Pargas, all by Hisinger, *q* from Pargas by v. Bonsdorff, *r* from Nordmark by v. Bonsdorff, *s* from Kienrud mine at Kongsberg by Kudernatsch :—

	n	*o*	*p*	*q*	*r*	*s*
Silica	47·62	53·50	41·50	45·69	48·83	49·07
Alumina	7·38	4·40	15·75	12·18	7·48	9·24
Magnesia	14·81	11·35	19·40	18·79	13·61	20·29
Lime	12·69	4·65	14·09	13·83	10·16	10·33
Protoxide of iron . .	15·78	22·52	7·75	7·32	18·75	9·77
Protox. mang. . . .	0·32	0·35	0·25	0·22	1·15	—
Hydrofluoric acid .	—	—	—	1·50	0·41	—
Water	—	0·60	0·50	—	0·50	—

o is supposed by Breithaupt to belong to a variety in which $mm' = 124^\circ$ nearly.

Analyses of black or brown amphibole showing the forms *b*, *c*, *t*, *m*, *r*, *k*, *o*, *i*, *z*, *v*, and in twin crystals, having a brown streak, and red or reddish-brown by transmitted light, G = 3·17 ...3·24 (basaltic hornblende), *t* from the Vogelsberg by v. Bonsdorff, *u* from the Wolfsberg near Czernuzin by Göschen, *v* from Aker by v. Bonsdorff, *w* from Lindbo in Westmanland by Hisinger, *x* of green or greenish-black amphibole from the Saualp in Carinthia (carinthine) by Clausbruch, *y* of a black mineral from the Baltym lake, having the form of pyroxene but the cleavage of amphibole (uralite) by Kudernatsch :—

	t	*u*	*v*	*w*	*x*	*y*
Silica	42·24	40·27	47·21	45·38	46·03	53·03
Alumina	13·92	16·36	13·94	13·82	8·37	4·56
Magnesia . . .	13·74	13·38	21·86	16·34	18·48	12·90
Lime	12·24	13·80	12·73	13·92	10·23	12·47
Protox. iron . . .	14·59	($\bar{\mathrm{F}}\mathrm{e}$ 15·34)	2·28	7·74	17·44	16·37
Protox. mangan. .	0·33	—	0·57	1·50	—	—
Hydrofluoric acid .	—	—	0·90	—	—	—
Water	—	0·46	0·44	0·23	—	—

Analyses of amphibole α from Kaltajuva in the Ural by Henry, β from Zsidovacz in Hungary, G = 3·136, by Kussin, γ from Kimito in Finland by Moberg, δ from Haavi on Fillefjeld by Sukow, ε greyish-green from Helsingfors, G = 3·166, by Pipping, ζ of tremolite from St. Gotthardt by Damour :—

	α	β	γ	δ	ε	ζ
Silica	45·18	46·01	43·23	45·37	57·20	58·07
Alumina	11·34	10·49	11·73	14·81	0·20	—
Magnesia	17·55	15·09	7·04	14·33	21·20	24·46
Lime	9·87	13·80	9·72	14·91	9·45	12·99
Protoxide of iron . .	16·16	10·03	26·81	8·74	11·75	1·82
Protox. mangan. . .	—	3·46	1·61	1·50	1·15	—

The amphibole, G = 3·270, from the mixture of augite and amphibole in the basaltic tufa of Härtlingen, according to Rammelsberg, consists of:—silica 42·52, alumina 11·00, magnesia 13·45, lime 12·25, protoxide of iron 16·11, protoxide of manganese 0·48, soda 1·71, potash 1·92, titanic acid 1·01.

In attached and imbedded crystals, columnar, fibrous and granular masses and disseminated.

The white, grey, green, semi-transparent or translucent varieties (grammatite) occur in long implanted crystals and columnar masses, in granular limestone or dolomite at Campo Longo on St. Gotthardt, Sebes in Transylvania, Bistrau in Bohemia, Pfitsch and Clausen in the Tyrol, Gullsjö, Aker and other places in Sweden, near Nantes in France in granite, Orawitza and Dognazka in the Banat, Massachusetts in the United States, Aberdeenshire, and in the marble of Glen Tilt in Scotland, Iona. The greenish-grey, leek-green and blackish-green varieties in long implanted crystals (actinote) are found in beds of iron ore in the older rocks of Ehrenfriedersdorf, Raschau and Breitenbrunn in Saxony, Gotteshaus in Bohemia, Arendal in Norway, Westmanland, Wärmeland and other places in Sweden, imbedded in talcose rocks on the Greiner in the Zillerthal in the Tyrol, on St. Gotthardt, Salzburg, the Bacher in Lower Stiria, Smrczek in Moravia. Anthophyllite is found at Kongsberg in Norway, Fiskenaes and several other places in Greenland, and in several parts of the United States. The fibrous varieties known by the names of mountain-wood, mountain-cork, &c., are found at Sterzing in the Tyrol, Johann-Georgenstadt in Saxony, Wischkowitz in Bohemia, Sahlberg in Sweden, Moravia, Switzerland, Spain, Dauphiné, Maryland in the United States, Strontian, Portsoy and Lead Hills in Scotland. The substance called amianthus or asbestus consists, for the most part, of amphibole in fibres so slender as to be flexible. It is found in Corsica, Piedmont, Savoy, Salzburg, the Tyrol, Dauphiné, Hungary, Silesia, in several of the United States, St. Keverne in Cornwall, Portsoy in Aberdeenshire, and in the islands of Unst and Fetlar. Common hornblende occurs in dark green or black crystals, massive or disseminated, as a constituent of many rocks, forming with albite diorite and dioritic porphyry, with felspar syenite, with quartz and mica hornblende rock and hornblende slate, and frequently in granite, gneiss, basalt and lava. It is found in the beds of iron ore at Arendal and Kongsberg in Norway, Sweden, Finland, Breitenbrum and Ehrenfriedersdorf in Saxony, Malleschau in Bohemia, Zillerthal and Pusterthal in the Tyrol, the Saualp in Carinthia. Basaltic hornblende occurs in black opaque crystals imbedded in basaltic rocks on the Wolfsberg near Czernuzin, Muckow, the Klotzberg and other places in Bohemia, in the Rhöngebirg, the Habichtswald, the Kaiserstuhl, Carboneira on Cabo de Gata in Spain. Uralite has the form of the combination *abmsp* of augite, but the cleavage of amphibole. The cleavages make equal angles with the face *b*, and their intersection is parallel to the edge *ab*. It sometimes contains a nucleus of augite. It is probably pseudomorphous. It is found in the green-stone porphyry of the Ural, on the Tavignolo near Predazzo in the Tyrol, Tunguraqua in Quito, the Mysore.

Amphibole is sometimes changed into a rust-coloured earth, in consequence of the conversion of the protoxide of iron into hydrate of red oxide of iron, and the loss of part of the lime and magnesia.

According to Mitscherlich, Berthier and G. Rose, grammatite and actinote, after being fused in a porcelain furnace, yield crystals having the form of augite.

Thomson's raphilite, a greyish or greenish-white mineral from Lanarck, Canada West, H = 5·5, G = 2·845, is tremolite according to T. S. Hunt. His analysis gave silica 55·30, lime 13·36, magnesia 22·50, protoxide of iron 6·30, alumina 0·40, manganese traces, potash 0·25, soda 0·80, loss by ignition 0·30.

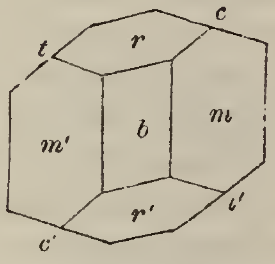
167. PARGASITE. — Pargasite; Phillips. Hornblende (in part); Hausmann. Amphibol (in part); Haidinger.

Isomorphous with amphibole.

b 010, *c* 001, *t* $\bar{2}01$, *m* 110, *r* $\bar{1}11$.

According to Nordenskiöld *mm′* = 124° 10′. A crystal in Mr. Brooke's collection gave *mm′* = 124° 0′, *rb* = 74° 9′, *rm* = 96° 1′.

FIG. 318.



Cleavage. *m*, perfect; *b*, traces. Fracture conchoidal...uneven. More or less translucent. Lustre vitreous, inclining to pearly. Blueish-green. Streak white. H = 5·0...6·0. G = 3·07...3·08. Melts before the blowpipe with ebullition. With borax yields an opaque, colourless bead.

Analyses of pargasite by C. G. Gmelin and v. Bonsdorff:—

Silica	51·75	46·26
Alumina	10·93	11·48
Magnesia	18·87	19·08
Lime	10·04	13·96
Protoxide of iron	3·97	3·48
Protoxide of manganese	1·83	0·36
Loss by ignition	2·51	FIH 1·60

Is found in imbedded crystals having their edges rounded, and in grains, in limestone at Pargas in Finland.

In several crystals of black amphibole from Vesuvius in Mr. Brooke's collection the angle *mm′* appears to be about 124° 10′. Breithaupt found the angle *mm′* = 124° nearly, in varieties of black amphibole, G = 3·290...3·462, from Arendal, Pehrsberg in Sweden, Schmalzgrube near Marienberg in Saxony, Rhonsberg in Bohemia, Greenland, and in a brown amphibole, G = 3·26...3·31, from La Prese near Bormio.

Analyses *a* of the amphibole from Greenland by Arfvedson, *b* from La Prese by Kudernatsch:—

	a	*b*
Silica	41·81	45·31
Alumina	12·14	11·88
Magnesia	11·20	14·28
Lime	11·55	10·49
Protoxide of iron	19·50	15·93
Protoxide of manganese . .	1·47	trace
Silica and titanic acid . . .	—	0·66

168. ARFVEDSONITE.—Arfvedsonite; Phillips. Peritomer Augit-Spath; Mohs. Arfvedsonit; Hausmann, Haidinger.

Probably isomorphous with amphibole.

b 010, *m* 110.

mm′ 123° 55′

Cleavage. *m*, very perfect; *b*, imperfect. Fracture imperfect conchoidal. Opaque. Lustre vitreous. Black. Streak greyish-green...celadon-green. H = 6·0. G = 3·328...3·44.

In thin fragments melts in the flame of a candle. Before the blowpipe melts very easily, with ebullition, into a black, magnetic bead. With borax yields a glass coloured by iron.

The oxygen in the silica and alumina together is to the oxygen in the bases as 12 to 5.

Analysis of arfvedsonite *a* by v. Kobell, and *b* of a greyish-black mineral from an island near Brevig, having the form of amphibole, erroneously called aegirine, and supposed to be a variety of arfvedsonite, by Plantamour:—

	a		*b*
Silica	49·27		46·57
Alumina	2·00		3·41
Protoxide of iron	36·12		24·38
Soda	8·00		7·79
Potash	trace		2·96
Lime	1·50		5·91
Magnesia	0·42		5·88
Protoxide of manganese . .	0·62		2·06
Chlorine	0·24	$\ddot{\mathrm{Ti}}$	2·02

The titanic acid in *b* is derived from a mechanical mixture of ilmenite.

Arfvedsonite is found in cleavable masses in a crystalline slate rock at Kangerluardsuk in Greenland, with sodalite, eudialyte, felspar and mesotype. Also in the south of Norway in zirconsyenite mingled with krokydolite, and in the beds of iron ore at Arendal. The arfvedsonite in Mr. Brooke's collection is very fusible, melting in the flame of a candle without the aid of the blowpipe. Hence there can be but little room for the doubt entertained by Breithaupt as to its identity with the mineral analyzed by v. Kobell.

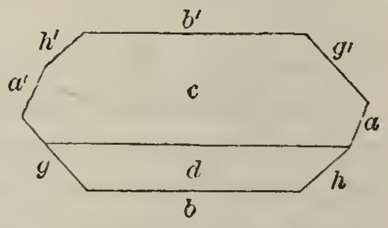
169. BABINGTONITE. — Babingtonite; Phillips, Beudant. Axotomer Augit-Spath; Mohs. Babingtonit; Hausmann, Haidinger.

Anorthic. 011,010 = 57° 51′, 001,010 = 87° 26′, 210,010 = 42° 55′, 100,010 = 67° 30′, 001,100 = 92° 0′.

a 100, *b* 010, *c* 001, *d* 011, *h* 210, *g* $\bar{1}10$.

bc	87°	26′	*gb*	47°	45′
ca	92	0	*ha*	24	35
ab	67	30	*dc*	29	35
hb	42	55	*db*	57	51

FIG. 319.



Combinations. *cbhg*, *cbahgd*. *a*, *b*, *h*, *g* striated parallel to their intersections with each other. *c*, *d* striated parallel to their intersections with *b*. Cleavage. *c*, perfect; *a*, less perfect. Fracture imperfect conchoidal. In thin fragments translucent. Lustre vitreous. Black. By transmitted light, brownish in a direction perpendicular to *c*, greenish in directions parallel to *c*. Streak greenish-grey. Brittle. H = 5·5...6·0. G = 3·355...3·406.

Before the blowpipe melts easily, with intumescence, into a brownish-black, bright, magnetic globule. Imparts the colour of iron to glass of borax. Is slowly decomposed by boiling hydrochloric acid.

Analysis of babingtonite from Arendal *a* by Arppe, *b* by R. D. Thomson:—

	a	*b*
Silica	54·4	47·46
Alumina	0·3	6·48

	a	*b*
Lime	19·6	14·74
Magnesia	2·2	2·21
Protoxide of iron	21·3	16·81
Protoxide of manganese	1·8	10·16
Loss by ignition	0·9	1·24

It contains a mechanical mixture of titanic iron ore, which may be separated from it by a magnet.

In small attached crystals, with amphibole, albite, felspar, epidote, in a bed of magnetite near Arendal in Norway, in quartz in the Shetland islands, in felspar at Gouverneur in New York, in prehnite at Charlestown in Massachusetts.

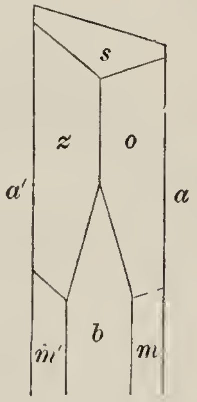
170. ACMITE.—Acmite; Phillips, Beudant. Paratomer Augit-Spath; Mohs. Achmit; Hausmann, Haidinger.

Oblique.

a 100, *b* 010, *m* 110.

ab	90°	0′
ma	46	32
mb	43	28
sb	59	45
sa	76	13

FIG. 320.



The intersection of the faces *s*, *b* makes angle of 74° with a normal to *a*. The edge *zo* makes an angle of 75° 50′ with a normal to *b*. Combination. *abmsoz*. Twins. Twin-face *a*. Cleavage. *m*, distinct; *a*, *b* less distinct. Fracture imperfect conchoidal...uneven. Nearly opaque. Lustre vitreous; surface of fracture glimmering or dull. Brownish-black, reddish-brown; surface of fracture blackish or greyish-green. Streak greenish-grey. H = 6·0...6·5. G = 3·53...3·55.

Melts readily before the blowpipe into a bright black magnetic globule. With salt of phosphorus yields a skeleton of silica and exhibits the reaction of iron. With borax fuses into a glass coloured by iron. With soda on platinum foil gives indications of manganese. In powder is partially decomposed by hydrochloric and sulphuric acids.

$\overset{\cdots}{\not{\mathrm{F}}}{}^2\overset{\cdot\cdot}{\mathrm{Si}}{}^3 + 2\dot{\mathrm{N}}\mathrm{a}\overset{\cdot\cdot}{\mathrm{Si}}$, silica 55·8, red oxide of iron 32·0, soda 12·2.

Analyses of acmite *a* by Ström, *b* by Berzelius, *c* by Lehunt, *d* by Rammelsberg:—

	a	*b*	*c*	*d*
Silica	54·27	55·25	52·02	54·13
Red oxide of iron . .	34·44	31·25	(Äl 0·69)	34·44
Protox. mang. . . .		1·08	3·49	T̄i 3·10
Protoxide of iron . .	—	—	28·08	—
Soda	9·74	10·40	13·33	not det.
Lime	—	0·72	0·88	—
Loss by ignition . . .	1·88	Ṁg	0·50	—

The titanic acid is supposed to be derived from a mechanical mixture of ilmenite.

Is found in the south of Norway in long crystals imbedded in quartz and felspar in granite at Rundemyr in the parish of Eger, and in syenite at Kless near Porsgrund.

The angles between the faces *a*, *b*, *m*, *s* are very nearly the same as in augite, with which it has been supposed isomorphous. Its constituents, however, are not isomorphous with those of augite.

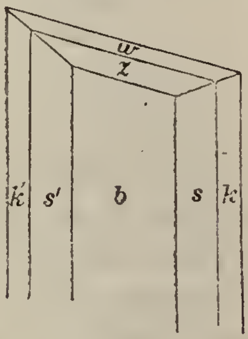
171. ZOISITE.—Zoisit; Werner.

Oblique.

b 010, *s* 110, *k* 210.

sb	58°	8′
kb	72	44
ss′	116	16
kk′	145	48
wk	56	30

FIG. 321.



Cleavage. *b*, very perfect. Lustre vitreous. Greyish-white, yellowish-grey...brown, green.

In the matrass yields moisture, which reddens litmus paper, and the assay grows darker. Before the blowpipe, in forceps, intumesces and fuses, without difficulty, into a slightly translucent, greenish-white, irregular mass. With a certain proportion of soda on platinum wire, in the outer flame, fuses into a transparent slightly greenish glass; with any other proportion of soda the globule is opaque. With borax, in the outer flame, fuses slowly into a perfectly transparent glass of a very light yellow colour whilst hot; perfectly colourless when cold. With salt of phosphorus fuses readily into a transparent glass, which is yellow whilst hot and colourless cold. With nitrate of cobalt becomes deep grey, approaching to black.

Analyses of zoiste from the Saualp in Carinthia *a* crystallized, *b* massive, both by Klaproth, *c* from the Fichtelgebirge by Bucholz, *d* from the Fichtelgebirge by Geffken, *e* from Williamsburgh by Thomson, *f* from Faltigl (G = 3·28) by Hermann:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	45	44·0	40·25	40·03	40·21	40·95
Alumina	29	32·0	30·25	29·83	25·59	30·34
Red ox. iron	3	2·5	4·50	$\dot{Fe}$ 4·24	7·68	4·96
Protox. mangan. . .	—	—	—	7·55	—	$\ddot{C}$ 1·13
Lime	21	20·0	22·50	18·85	23·28	21·56
Water	—	—	2·00	—	1·71	0·56

Is found in attached crystals on the Saualp in Carinthia, Sterzing in the Tyrol, Fernleite in Fusch in Salzburg, Baireuth, Conradsreuth near Hof in Bavaria, the Ural.

It is doubtful whether the analyses *c*, *d*, *e*, *f* refer to zoisite or to epidote, with which, as we afterwards state, it has been confounded. In October, 1831, Mr. Brooke gave an account of the crystalline form of this mineral, by which its form appears to approach very nearly to that of euclase, if not to be identical with it. Zoisite is usually considered to be a variety of epidote, and the distinction between the two substances is generally described as one of colour only, yet they have not any corresponding cleavages, faces, or angles. For it will be found that the crystals of epidote are invariably lengthened in the direction of a perpendicular to the face *b*, while those of zoisite are as invariably lengthened in the direction of the edge *kk′*. The principal cleavage of zoisite is parallel to the face *b*, corresponding to that of euclase, while the principal cleavages of epidote are perpendicular to the face *b*. The distinction between the two substances is therefore so strongly marked as to lead to the conclusion that they have not been examined and compared by any of the authors who rest the distinction between them chiefly on the difference of colour.

172. EPIDOTE. — Epidote; Phillips, Hauy. Prismatoidischer Augit-Spath; Mohs. Epidot; Hausmann, Haidinger.

Oblique. 101,100=63° 43′; 111,010=35° 16′·5 ; 101,001=51° 41′.

m 100, *b* 010, *t* 001, *z* 011, *u* 012, *i* 201, *s* 302, *r* 101, *l* 102, *f* 103, *o* 110, *k* 210, *n* 111, *x* 211, *y* 112, *q* 122, *d* $\bar{1}$11.

im	34°	21′	*nn′*	70°	33′	*xm*	51°	55′
sm	45	37	*xb*	48	21	*nm*	75	11
rm	63	43	*xx′*	96	41	*qm*	89	42
lm	89	27	*km*	39	9	*zm*	104	16
fm	98	38	*om*	58	26	*dm*	117	49
tm	115	24	*bm*	90	0	*yt*	45	5
em	145	17	*kk′*	101	43	*nt*	69	1
ut	35	27	*oo′*	63	8	*ot*	102	59
zt	54	56	*dd′*	96	10	*td′*	130	11
tb	90	0						
uu′	109	6						
zz′	70	9						
yl	38	15						
ql	57	37						
yy′	103	30						
qq′	64	46						
nr	54	44						

FIG. 322.

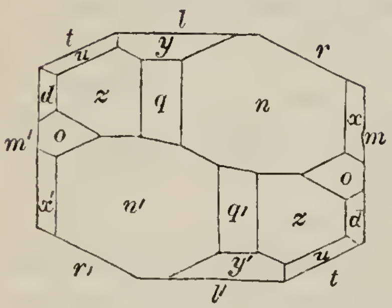
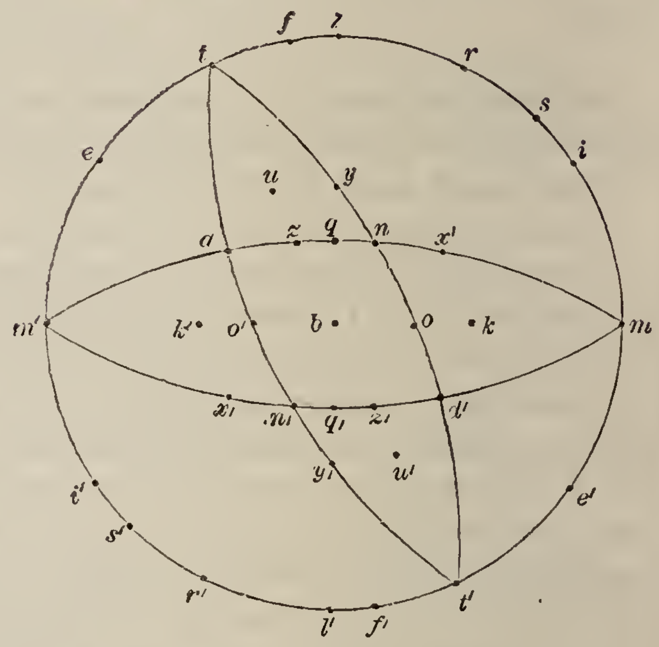


FIG. 323.



Combinations. *rntm*, *lrztumb*, *rntuomb*, *lrnxyqtuzdom*. Twins. 1. Twin-face *t*; 2. twin-face *m*, seldom. Cleavage. *m*, perfect; *t*, less perfect; *l*, in thulite. Fracture uneven. *l*, *y*, *q*, *z* striated parallel to their intersections with each other. Semi-transparent...transparent on the edges. Lustre vitreous. R = 1·7. Pearly on the faces of perfect cleavage. Green, yellow, brown, red, black. Streak grey; in the variety from St. Marcel red. Exhibits pleochroism. A ray traversing the crystal in a plane parallel to *b* and polarized in that plane is almost entirely absorbed. The optic axes lie in a plane parallel to *b*, and make angles of about 46° 30′ with a normal to *t*. On looking through a crystal in the direction of either optic axis a light-coloured stripe is seen between two dark spots. Brittle. H = 6·5. G = 3·0...3·5.

Before the blowpipe the green varieties swell and exfoliate; they melt with great difficulty on the edges into a clear glass;

the varieties containing a large quantity of oxide of iron melt rather more easily; the varieties containing a large quantity of oxide of manganese melt readily into a black glass. With borax the green and black varieties yield a green glass; the blackish-red varieties a glass which is violet in the outer flame, and colourless in the inner flame. In powder after fusion or ignition is decomposed by hydrochloric acid, forming a jelly of silica. By ignition the specific gravity of epidote from Arendal is reduced from 3·403 to 3·271.

$\dot{\mathrm{C}}\mathrm{a}^3\ddot{\mathrm{S}}\mathrm{i}^2 + 2\dddot{\bar{\mathrm{R}}}\ddot{\mathrm{S}}\mathrm{i}$, where part of the $\dot{\mathrm{C}}\mathrm{a}$ is replaced by $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{M}}\mathrm{n}$, and $\dddot{\bar{\mathrm{R}}}$ is $\dddot{\bar{\mathrm{A}}}\mathrm{l}$, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ or $\dddot{\bar{\mathrm{M}}}\mathrm{n}$. Several varieties from the north of Europe contain a small quantity of oxide of tin; epidote from Orrijerfvi contains nearly 1 per cent.

Analyses of epidote *a* from Arendal, *b* from Rothlaue near Gutannen in the Haslithal, G = 3·387, both by Rammelsberg, *c* from Geier in the Erzgebirge, *d* dark-green from Dauphiné, *e* from Penig, *f* from Arendal, all by Kühn:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	37·98	44·56	40·57	39·85	38·64	36·68
Alumina	20·78	23·72	14·47	21·61	21·98	21·72
Red oxide of iron .	17·24	8·33	13·44	16·61	17·42	16·72
Lime	23·74	24·71	30·00	22·15	21·95	23·07
Magnesia	1·11	—	2·76	0·30	0·27	0·53

Analyses *g* of blackish-green epidote, G = 3·49, from Arendal, *h* from Burowa south of Miask, G = 3·35, *i* olive-green, G = 3·38, from Bourg d'Oisans, *k* grass-green, G = 3·39, from Achmatowsk, *l* black, G = 3·51, from Achmatowsk, *m* green, G = 3·33...3·34, from Achmatowsk, all by Hermann:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	36·79	36·87	37·60	37·38	36·97	36·45
Alumina	21·24	18·13	18·57	18·25	21·84	24·92
Red ox. iron . . .	12·96	14·20	13·37	12·31	10·19	9·54
Protox. iron . . .	5·20	4·60	5·55	2·20	9·19	3·25
Lime	21·27	21·45	21·19	24·72	21·14	22·45
Magnesia	—	0·40	1·40	0·39	—	—
Soda	—	0·08	—	0·91	—	—
Carbonic acid . . .	2·31	0·89	1·22	1·61	0·32	2·73
Water	0·55	0·67	0·46	0·59	0·68	0·77

h contains also soda 0·08 and traces of boracic acid, *k* traces of boracic acid.

Analyses of epidote *n* from Arendal, G = 3·37, by Hermann, *o* from Arendal by Rammelsberg, *p* from Arendal by Geffken, *q* from Zwiesel by Kühn, *r* from Bourg d'Oisans by W. Baer:—

	n	*o*	*p*	*q*	*r*
Silica	37·32	38·76	36·14	40·62	37·78
Alumina	22·85	20·36	22·24	29·18	21·25
Red ox. iron	11·56	16·35	14·29	6·19	15·97
Protox. iron	1·86	$\dot{\mathrm{M}}\mathrm{n}$	2·12	—	—
Lime	22·03	23·71	22·86	22·67	23·46
Magnesia	0·77	0·44	2·38	0·73	0·61
Carbonic acid . . .	2·64	—	—	$\dot{\mathrm{N}}\mathrm{a}$	0·41
Water	0·29	2·00	—	0·42	—

Analyses of epidote *s*, a variety remarkable for its pleochroism, (puschkinite) by Wagner, *t* (puschkinite), G = 3·43, from Werchneiwinsk by Hermann, *u* a rose-red variety, G = 3·124 (thulite) from Souland in Tellemarken by C. Gmelin, *v* manganesian epidote, G = 3·404, from St. Marcel in Piedmont by Geffken, *w* by Hartwall, *x* by Sobrero:—

	s	*t*	*u*	*v*	*w*	*x*
Silica	38·88	37·47	42·81	36·87	38·47	37·86
Alumina	18·85	18·64	31·14	11·76	17·65	16·30
Red oxide of iron . .	16·34	14·15	2·29	10·33	6·60	—
Protoxide of iron . .	—	2·56	—	—	—	7·41
Ox. mangan. $\ddot{\overline{\mathrm{M}}}\mathrm{n}$ . .	0·26	—	1·63	18·25	14·08	18·96
Lime	16·00	22·06	18·73	22·78	21·65	13·42
Magnesia	6·10	—	—	—	1·82	—
Soda	1·67	2·28	1·89	—	—	—
Lithia	0·46		—	—	$\dot{\mathrm{M}}\mathrm{n}$	4·82
Water	—	0·65	0·64	—	—	—
Carbonic acid . . .	—	0·79	—	—	$\ddot{\mathrm{S}}\mathrm{n}$, $\dot{\mathrm{C}}\mathrm{u}$	0·40

In *u* the iron is probably in the state of protoxide.

In attached crystals, columnar and granular masses. The crystals are almost invariably attached by the face opposite to *b*, and elongated in the direction of the axis of the zone *mrt*.

Occurs in granite, syenite, diorite, euphotide, diabase, trap, porphyry and various crystalline slate rocks. Is found at Arendal in Norway, Norberg and Langbanshytta in Sweden, Mont Blanc and many other parts of the Alps, Bourg d'Oisans in Dauphiné, Rächety near Katharinenburg, Slatoust and many other places in the Ural, in the Pyrenees, Schriesheim in Baden, Auerbach in Darmstadt, the Fichtelgebirge, Bohemia, Moravia, Silesia, Saxony, Monzoni, and in amygdaloidal rocks at Predazzo in the Tyrol, Finland, Greenland, the United States, in crystals which are red and yellow respectively in two directions at right angles to each other in a plane parallel to the face *b* at Glenco in Argyleshire in trap. The rose-red variety (thulite) is found at Souland in Tellemarken in Norway. Manganesian epidote in long imperfect crystals of a dark red colour, and having a red streak, is found at St. Marcel in the valley of Aosta.

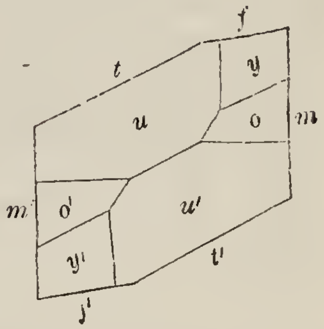
173. BUCKLANDITE.—Bucklandit; Mohs, Hausmann, Haidinger.

Oblique. Isomorphous with epidote.

m 100, *t* 001, *u* 012, *f* 103, *o* 110, *y* 112.

fm	99°	41′	*oo′*	63°	0′
tm	114	55	*ut*	35	20
ft	15	14	*om*	58	30
tm′	65	5	*yu*	19	36
uu′	109	20			

FIG. 324.



Fracture uneven. Opaque. Lustre vitreous. Dark brown, black. Streak grey. H = 6·0. G = 3·865 (from Laach).

Before the blowpipe melts with intumescence into a bright, black, magnetic slag, which, when the intumescence ceases, becomes very infusible. With Fluxes yields the reaction of iron.

Is supposed to be $\dot{\mathrm{F}}\mathrm{e}^3\ddot{\mathrm{S}}^2 + 2\dddot{\bar{\mathrm{F}}}\ddot{\mathrm{S}}$.

Is found in small crystals in the Neskiel mine at Arendal, in rhyacolite in volcanic rocks at the lake of Laach, and in granite at Werchoturje in Siberia.

174. BRAGATIONITE. — Bragationit; v. Kokscharow. Poggendorff's Annalen. 1848.

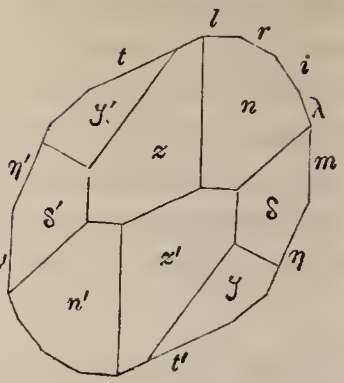
Oblique. 101,100 = 63° 25′; 111,010 = 35° 48′; 101,001 = 51° 30′.

m 100, *t* 001, *z* 011, *r* 101, *l* 102, *i* 201, λ 301, η 20$\bar{1}$, *n* 111, δ 21$\bar{1}$, ζ 11$\bar{2}$.

λ*m*	22°	22′	*rm*	63°	25′	*tm*	114°	55′
im	34	19	*lm*	88	58	η*m*	157	20

nn′	71°	36′	*ζη*	37°	11′
zz′	70	50	*ζδ*	20	41
ζζ′	121	15	*ζz*	28	31
δδ′	118	17	*λz*	91	29
mn	74	50	*iz*	84	35
nz	29	18	*zr*	68	51
zδ	38	15	*zl*	58	36
δm′	37	37	*ni*	59	16
δt	50	30	*nλ*	63	50
ζt	34	17	*nt*	68	39

FIG. 325.



Fracture uneven...conchoidal. Opaque. Lustre vitreous; on *m* imperfect metallic. Black. Streak dark brown. H = 6·5. G = 4·115.

Intumesces before the blowpipe, and melts into a bright, black, magnetic globule. With borax forms a green glass in the inner flame, and a glass which is orange while hot in the outer flame. In salt of phosphorus leaves a skeleton of silica.

Is found with diopside and chlorite in the Achmatowsk mine near the Kussinsk iron-works in the district of Slatoust in the Ural.

The form of bragationite agrees very closely with that of epidote.

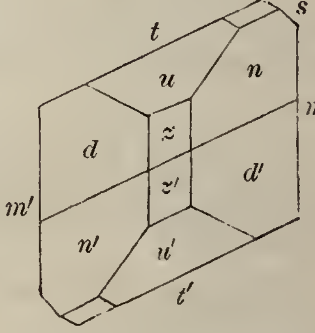
175. ALLANITE.—Allanite, orthite; Phillips. Cérium oxidé siliceux noir; Hauy. Tetartoprismatisches Melan-Erz, Prismatoidisches Melan-Erz; Mohs. Allanit; Hausmann. Allanit, Orthit, Cerin; Haidinger.

Oblique. 101,100 = 63° 40′; 111,010 = 35° 45′; 101,001 = 51° 15′.

m 100, *t* 011, *r* 101, *s* 302, *u* 012, *z* 011, *n* 111, *d* $\bar{1}$11.

sm	34°	30	*nn′*	71°	30′
rm	63	40	*dd′*	96	37
tm	114	55	*nt*	68	33
ut	35	7	*td′*	130	17
zt	54	35	*nm*	74	59
uu′	109	47	*zm*	104	8
zz′	70	51	*dm*	127	40

FIG. 326.



Fracture conchoidal...uneven. Opaque. In thin splinters feebly translucent. Lustre imperfect metallic, inclining to vitreous or resinous. Black passing into brown or green. Brown by transmitted light. Streak greenish-grey...brownish-grey. Brittle. H = 6·0. G = 3·1...4·2.

Melts before the blowpipe with intumescence into a brown or black magnetic glass. Most varieties are decomposed by hydrochloric acid, forming a jelly. The allanite from Snarum is but very imperfectly decomposed, and that from Bastnäs entirely resists the action of the acid.

$\dot{\text{R}}^3\ddot{\text{Si}}^2 + \overset{\cdots}{\rlap{\,-}\text{R}}\ddot{\text{Si}}$, where $\dot{\text{R}}$ is $\dot{\text{C}}\text{a}$, $\dot{\text{C}}\text{e}$, $\dot{\text{F}}\text{e}$ and $\overset{\cdots}{\rlap{\,-}\text{R}}$ is $\overset{\cdots}{\rlap{-}\text{F}}\text{e}$, $\overset{\cdots}{\text{A}}\text{l}$.

Analyses of allanite *a*, *b* from Jotum-Fjeld, *c*, *d* from Snarum, of the variety called orthite *e* from Fille-Fjeld, *f* from Hitteröe, G = 3·5, all by Scheerer:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	34·69	35·15	35·75	34·00	34·93	32·77
Alumina	15·58	16·23	15·49	16·40	14·26	14·32
Protox. iron . . .	14·42	15·55	15·19	15·51	14·90	14·76
Protox. cerium . .	19·65	13·34	19·96	13·73	21·43	17·70
Ox. lanthanium . .		5·80		7·80		2·31
Protox. mangan. . .	1·55	0·98	—	—	0·85	1·12
Yttria	—	—	—	—	1·91	0·35
Lime	11·90	12·02	11·25	11·75	10·42	11·18
Magnesia	1·09	0·78	0·77	0·56	0·86	0·50
Water	0·52	0·50	—	—	0·52	2·51

Analyses of orthite *g* from Werchoturie, G = 3·48...3·66, *h*, *i* from Miask, G = 3·41...3·647 (ural orthite) by Hermann, *k* from Miask by Rammelsberg, *l* from Hitteröe, G = 3·546, by Scheerer, the proportions of $\dot{\text{F}}\text{e}$ and $\bar{\rlap{-}\text{F}}\text{e}$ being determined by Rammelsberg, *m* the variety called cerine from the Bastnäs mine near Riddarhytta by Scheerer:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	32·46	34·47	35·49	34·08	33·81	32·06
Alumina	18·09	14·36	18·21	16·86	13·04	6·49
Red ox. iron . . .	13·84	7·67	—	7·35	8·16	25·26
Protox. iron . . .		8·24	13·03	7·90	8·30	—
Protox. cerium . .	6·77	14·79	10·85	21·38	20·50	23·80
Ox. lanthanium . .	9·76	7·66	6·54			2·45
Ox. mangan. . . .	—	—	2·37	$\dot{\text{K}}$	0·67	—
Yttria	1·50	—	($\dot{\text{C}}\text{u}$	0·13)	1·45	—
Lime	13·18	10·20	9·25	9·28	9·42	8·08
Magnesia	1·02	1·08	2·06	0·95	0·38	1·16
Water	3·40	1·56	2·00	1·32	3·38	0·60

Analyses of orthite *n* from Finbo, *o* from Gottliebsgang, both by Berzelius, *p* from Ytterby, *q* from the Park at Stockholm, G = 3·41, *r* from Kullberg near Stockholm, G = 2·88, both by Berlin, *s* from Eriksberg in Stockholm, G = 2·78, by Bahr:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	36·25	32·00	36·24	33·05	27·59	32·93
Alumina	14·00	14·80	8·18	15·29	16·14	15·54
Protoxide of iron	11·42	12·44	9·06	16·64	16·01	4·21
Oxide of cerium	17·39	19·44	4·98	20·55	11·75	20·01
Oxide of lanthanium	—	—	—			
Lime	4·87	7·84	5·48	10·18	2·28	6·76
Protoxide of mangan.	1·36	3·40	—	1·58	1·55	0·39
Magnesia	—	—	0·61		4·94	2·15
Yttria	3·80	3·44	29·81	1·18	2·12	0·59
Water	8·70	5·36	4·59	1·24	11·46	17·55
Potash and Ṅa	—	—	0·61	C̈	6·71	

The varieties containing water are supposed to be more or less decomposed.

Analyses of allanite *t*, *u* (G = 3·790) from Schmiedefeld near Suhl in Thuringia by Credner, *v* from Iglorsit in Greenland by Stromeyer, *w* cerine from Bastnäs by Hisinger:—

	t	*u*	*v*	*w*
Silica	36·82	37·55	33·02	30·17
Alumina	16·94	15·99	15·23	11·31
Oxide of lanthanium	13·22	9·30	—	—
Protoxide of cerium		3·19	21·60	28·19
Yttria	17·11	0·56	Ċu	0·87
Protoxide of iron		16·83	15·10	20·72
Protoxide of manganese	0·56	0·23	0·40	—
Lime	14·84	13·60	11·08	9·12
Magnesia	0·86	0·22	—	—
Water	0·28	1·80	3·00	—

Allanite is found in long acicular crystals and granular masses in Greenland at Iglorsoit, Alluk, and several other places in granite; in Norway at Hitteröe in granite; at Jotum-Fjeld and Snarum. The variety called orthite in granite at Finbo near Fahlun, at Stockholm in gneiss, at several other places in Sweden, Fille-Fjeld and Hitteröe in Norway, in the granite of the Thüringerwald, Werchoturie and Miask in the Ural. The variety called cerine at Riddarhytta in Sweden.

The form of allanite is shown by v. Kokscharow to approach very closely to that of epidote. At Sillböhle near Helsingfors crystals of epidote frequently occur, the interior of which consists of orthite. The crystal described by Haidinger assumed the appearance of belonging to the anorthic system, in consequence of the enlargement of some faces at the expense of others. According to Breithaupt the crystals are pseudomorphous.

The pyrorthite from Kararfvet near Fahlun is supposed to be allanite containing a mechanical admixture of carbon. When ignited at one point it burns on without flame or smoke; after which it becomes white, very porous, and may be melted with difficulty into a black globule. With borax in the inner flame forms a blood-red glass which becomes yellow on cooling.

According to Berzelius, it consists of:—

Silica	10·43
Alumina	3·59
Lime	1·81
Protoxide of cerium	13·92
Protoxide of iron	6·08
Yttria	4·87
Protoxide of manganese	1·39
Water	26·50
Carbon and loss	31.41

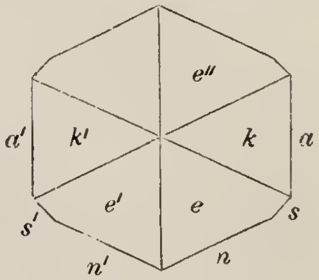
176. MONTICELLITE.—Monticellite; Brooke. Philosophical Magazine, October, 1831. Monticellit; Mohs, Hausmann, Haidinger.

Prismatic. 011,010 = 37° 22′; 101,001 = 48° 46′; 110,100 = 48° 55′.

a 100, *k* 101, *s* 110, *n* 120, *e* 122.

ka	41° 14′	*ea*	70° 54′
kk′	97 32	*en*	35 0
sa	48 55	*ee′*	38 12
na	66 27	*ee″*	97 20
nn′	47 6	*e′e″*	110 0

FIG. 327.



No cleavage observable. Nearly transparent. Lustre vitreous. Colourless, yellowish. H = 5·5. G = 3·245...3·275.

In powder soluble in hydrochloric acid.

$\dot{C}^2\ddot{S}i + \dot{M}g^2\ddot{S}i$, Scacchi.

Is found in crystals imbedded in granular limestone, with mica and augite, on Monte Somma.

The angles between the faces of monticellite cannot be determined with much accuracy, on account of the want of evenness of the faces. They approximate to those of olivine, yet differ too much to allow of the union of monticellite and olivine in one species.

177. OLIVINE.—Chrysolite; Phillips. Peridot; Hauy. Prismatischer Chrysolith; Mohs. Chrysolith; Hausmann, Haidinger.

Prismatic. 011,010=38°27′; 101,001=49°33′·4; 110,100=47° 1′·4.

a 100, *b* 010, *c* 001, *d* 011, *h* 102, *k* 101, *i* 201, *n* 120, *s* 110, *r* 320, *z* 210, *g* 144, *e* 122, *f* 111, *l* 322.

db	38°	27′	*ra*	35°	35′	*ga*	79°	40′
cb	90	0	*sa*	47	1	*da*	90	0
dd′	103	6	*na*	65	1	*lb*	58	7
ia	23	5	*ba*	90	0	*lc*	65	12
ka	40	27	*rr′*	108	50	*fb*	50	46
ha	59	36	*ss′*	85	57	*fc*	59	51
ca	90	0	*nn′*	49	58	*eb*	42	38
kk′	99	7	*la*	42	25	*ec*	54	15
hh′	60	48	*fa*	53	53			
za	28	13	*ea*	69	57			

FIG. 328.

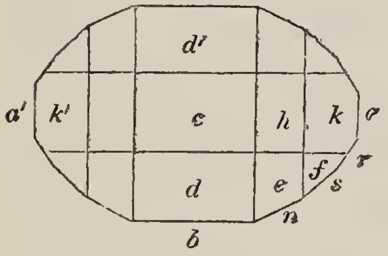


FIG. 329.

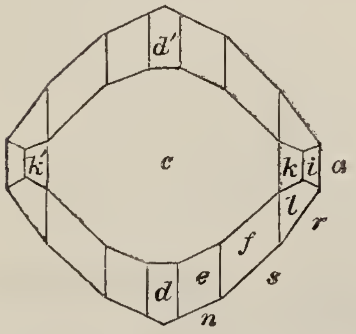
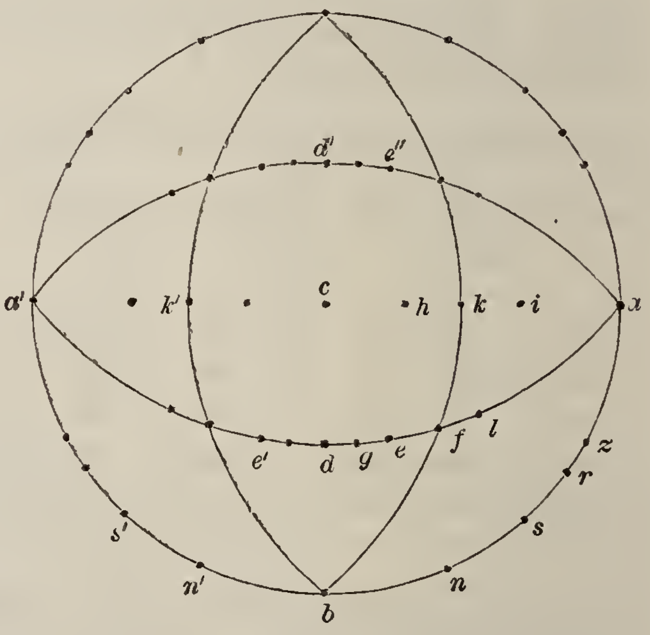


FIG. 330.



Combinations. *denb*, *defnb*, *knadsc*, *cbadksze*, *kna..d.e.s*, *cdenab.f.h.k.s.r*, *cfeldkinsra*. The faces *c*, *a* usually rough. *n*, *s*, *r*, *z* striated parallel to their intersections with each other. Cleavage. *a* easily obtained, *b* traces. Fracture conchoidal. Transparent...translucent. Lustre vitreous. R = 1·660. Green, yellow, brown. Streak white. H = 6·5...7·0. G = 3·3...3·44.

Grows dark before the blowpipe; is infusible, excepting hyalosiderite, which melts into a black magnetic globule. With salt of phosphorus yields the reactions of iron and silica. With soda melts into a brown slag. Is easily and completely decomposed by sulphuric acid, forming a jelly.

$\dot{M}g^{2}\ddot{S}i$, silica 42·75, magnesia 57·25, part of the $\dot{M}g$ being replaced by $\dot{F}e$.

Analyses *a* of the transparent variety (chrysolite), of the less transparent varieties (olivine), *b* from the Vogelsberg near Giessen, *c* from Kasalthoff in Bohemia, *d* from the Iserwiese, *e* from Bohemia, *f* from Monte Somma (mean of two analyses) by Walmstedt:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	39·73	40·09	40·54	41·54	41·42	40·12
Magnesia	50·13	50·49	50·67	50·04	49·61	44·54
Protoxide of iron . .	9·19	8·17	8·07	8·66	9·14	15·32
Oxide of nickel . .	0·32	0·37	0·33	—	—	—
Oxide of manganese .	0·09	0·20	0·18	0·25	0·15	0·29
Alumina	0·22	0·19	0·19	0·06	0·15	0·14

Analyses of olivine *g* from the basalt of Langeac by Berthier, *h* from Greenland by Lappe, *i* from the talc slate of Syssersk in the Ural (G = 3·39...3·43) by Hermann, *k* by Beck, *l* from Le Puy in Vivarais by Walmstedt, *m* from the Thjorsá lava of Hekla (G = 3·226) by Genth:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	40·8	40·00	40·04	39·21	41·44	43·44
Magnesia	41·6	43·09	42·60	44·06	49·19	49·31
Protoxide of iron . .	16·4	16·21	17·58	17·45	9·72	6·93
Oxide of nickel . .	—	0·55	0·15	($\dot{C}a$	0·21)	0·32
Oxide of manganese .	—		—	—	0·13	—
Alumina	—	0·06	—	—	0·16	traces

Analyses of olivine *n* from the Otumba iron in South America, *o* from the Pallas iron by Stromeyer, *p* from the Pallas iron by Berzelius, *q* from the Pallas iron, *r* from Monte Somma, both by Walmstedt, *s* of the partially decomposed olivine (hyalosiderite) having a semi-metallic lustre and brown tarnish (G = 2·875) from the Kaiserstuhl in Baden by Walchner:—

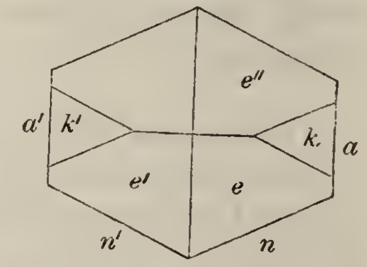
	n	*o*	*p*	*q*	*r*	*s*
Silica	38·25	38·48	40·86	40·83	40·08	31·63
Magnesia	49·68	48·42	47·35	47·74	44·22	32·40
Protox. iron . . .	11·75	11·19	11·72	11·53	15·26	28·49
Protox. man. . . .	0·11	0·34	0·43	0·29	0·48	0·48
Alumina	—	0·18	—	—	0·18	2·21
Oxide of tin . . .	—	—	0·17	—	$\dot{K}$	2·79

According to Rummler the olivine from the Pallas iron, and the iron from Atacama, contains a trace of arsenious acid.

In attached, imbedded and isolated crystals; in granular masses, the grains being slightly coherent.

The green transparent variety (chrysolite) is found in Egypt, Natolia, and the Brazils. The less transparent varieties (olivine) in imbedded crystals and granular aggregations, in the islands of Palma and Bourbon, in the basalts of the Habichtswald, the Eiffel, the Upper Palatinate, Geysingberg near Altenberg, Hutberg near Herrenhut, Kapfenstein in Stiria, in masses of rock ejected by Vesuvius, in cavities of the obsidian of Cerro de las Navajas in Mexico, in syenite at Elfdalen in Sweden, in the meteoric iron of Krasnojarsk, Otumba, and Steinbach. The brown variety (hyalosiderite) is found at Sasbach and Iringen on the Kaiserstuhl, and in dolerite near Freiburg in Baden.

FIG. 331.



The angles of Levy's 'forsterite,' deduced from the measurements of some very good crystals in Mr. Brooke's collection, do not differ sensibly from those of olivine. The combination *abdkhrsnefl* was observed. The faces *r*, *s* truncating the edge *an*, *d* truncating *ee'*, *h* truncating *ee''*, *l*, *f* truncating *ae*, were all very narrow. Cleavage. *a*, *c*. Transparent. Lustre vitreous. Colourless. H = 7·0. According to Children contains silica and magnesia. Is probably $\dot{\mathrm{M}}\mathrm{g}^2\ddot{\mathrm{S}}\mathrm{i}$. Occurs in attached crystals with pleonaste and augite on Vesuvius.

178. BATRACHITE.—Batrachit; Mohs, Hausmann, Haidinger.

Cleavage in two directions, making with each other an angle of 115° and 65° nearly, and a third bisecting the obtuse angle between the two former; all imperfect. Fracture imperfect conchoidal. Translucent. Lustre resinous, inclining to vitreous. Light greenish-grey, white. Streak white. H = 5·0. G = 3·033. Fusible before the blowpipe.

$\dot{\mathrm{C}}\mathrm{a}^2\ddot{\mathrm{S}}\mathrm{i} + \dot{\mathrm{M}}\mathrm{g}^2\ddot{\mathrm{S}}\mathrm{i}$, part of the $\dot{\mathrm{M}}\mathrm{g}$ being replaced by $\dot{\mathrm{F}}\mathrm{e}$.

Analysis by Rammelsberg:—

Silica	37·69
Lime	35·45
Magnesia	21·79
Protoxide of iron	2·99
Water	1·27

Is found at Rizoni in the Tyrol.

179. FAYALITE.—Fayalit; Hausmann, Haidinger.

Prismatic.

Cleavage in two directions, making right angles with each other. Fracture imperfect conchoidal...uneven. Opaque. Lustre imperfect metallic, approaching to resinous on surface of fracture. Iron-black, inclining to green or brown. Sometimes having a pinchbeck-brown, brass-yellow or iridiscent tarnish. H = 6·5. G = 4·11...4·14. Magnetic.

Before the blowpipe melts easily into a black, brittle, magnetic globule. Imparts the colour of iron to glass of borax.

$\dot{\mathrm{F}}\mathrm{e}^2\ddot{\mathrm{S}}\mathrm{i}$, silica 29·96, protoxide of iron 60·04.

Analyses of fayalite from Slavcarrach *a* by Thomson, from Fayal *b* by C. G. Gmelin, from Fayal *c* by v. Fellenberg:—

	a	*b*	*c*
Silica	29·60	24·93	31·04
Protoxide of iron	68·73	65·84	62·57
Protoxide of manganese . .	1·78	2·94	0·79
Alumina	—	1·84	3·26
Lime	—	—	0·43
Oxide of copper	—	0·60	0·32
Sulphide of iron ($\acute{\mathrm{F}}\mathrm{e}$) . . .	—	2·77	—
Oxide of lead	—	—	1·71

b, *c* are mechanical mixtures of $\dot{\mathrm{F}}\mathrm{e}^2\ddot{\mathrm{S}}\mathrm{i}$, which can be decomposed by hydrochloric acid, and a very variable quantity of a compound incapable of being decomposed by hydrochloric acid.

Is found in large nodules and angular pieces on the seashore in Fayal, and on Slavcarrach, one of the Morne mountains, in Ireland.

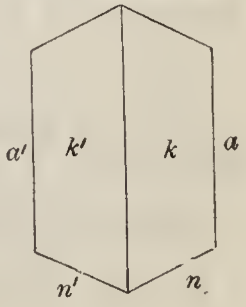
Crystals having the composition of fayalite, and very nearly the form of olivine, are frequently found in refinery cinder, and in the slags of copper furnaces.

011,010 = 38° 32′; 101,001 = 49° 11′; 110,100 = 47° 20′.

a 100, *b* 010, *c* 001, *d* 011, *h* 102, *k* 101, *n* 120, *u* 340, *s* 110, *r* 320, *v* 520, *e* 122, *f* 111, *l* 322.

db	38°	32′	*ra*	35°	52′
cb	90	0	*sa*	47	20
ka	40	49	*ua*	55	20
ha	59	56	*na*	65	12
ca	90	0	*ba*	90	0
kk′	98	22	*la*	42	45
hh′	60	8	*fa*	54	12
va	23	27	*ea*	70	10

FIG. 332.



Combinations. *kn*, *akn*, *abk*, *akmn*, *akmnc*, *akmncbhdlurv*. Cleavage. *c* very perfect, *a* less perfect, *b* indistinct. Translucent...opaque. Olive-green...black. H = 6·0.

Analyses of crystals from refinery cinder *a* (G = 3·700), *b* (G = 3·529), both by Walchner, *c* by Mitscherlich, *d* black opaque crystals (G = 4·08) which may be considered pseudomorphous, part of the protoxide of iron having been converted into the red oxide, by Percy; from copper slags *e* by Mitscherlich, *f* by Walchner:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	32·96	32·35	31·16	29·60	30·93	29·25
Protoxide of iron . .	61·24	62·04	67·24	48·43	69·07	63·32
Red oxide of iron .	—	—	—	17·11	$\dot{\mathrm{C}}$u	2·65
Magnesia	1·90	1·40	0·25	0·35	—	1·30
Oxide of manganese .	1·30	2·65	—	1·13	—	1·46
Alumina	1·56	1·02	—	1·28	—	1·24
Potash	0·20	0·29	($\dot{\mathrm{C}}$a	0·47)	—	0·18
Phosphoric acid . .	—	—	—	1·34	—	—
Sulphuret of iron . .	—	—	—	1·61	—	—

180. TEPHROIT.—Tephroit; Mohs, Hausmann, Haidinger.

Cleavage in two directions, making right angles with each other. Fracture uneven...imperfect conchoidal. Lustre adamantine. Ash-grey. Acquires a brown or black tarnish. Streak ash-grey. H = 5·5. G = 4·06...4·12.

Before the blowpipe melts very easily into a brown or black slag. With borax in the outer flame fuses into a glass which is violet while warm, and becomes red on cooling. Is decomposed by hydrochloric acid forming a jelly of silica.

$\dot{\mathrm{M}}\mathrm{n}^2\ddot{\mathrm{S}}\mathrm{i}$, silica 30·22, protoxide of manganese 69·78.

Analyses by Thomson and Rammelsberg:—

Silica	29·64	28·66
Protoxide of manganese . .	66·60	68·88
Protoxide of iron	0·92	2·92
Water	2·70	—

Is found in cleavable and granular masses with franklinite at Franklin in New Jersey.

181. WILLEMITE.—Willemine; Beudant. Brachytyper Zink-Baryt; Mohs. Willemit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 30° 7′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *r* 100, *s* $\bar{1}11$.

bo	90°	0′	*rb*	59°	53′	*so*	49°	14′
bb″	60	0	*ra′*	64	15	*ss′*	82	0
ab	30	0	*rr′*	51	30	*sr′*	41	0
ro	30	7						

FIG. 333.

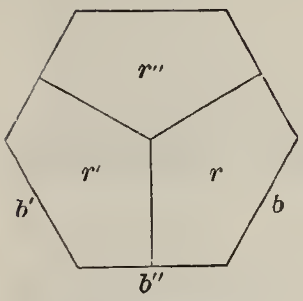


FIG. 334.

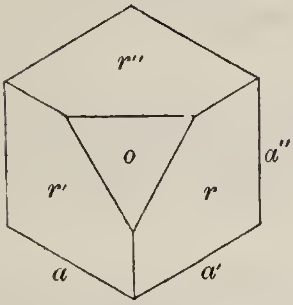
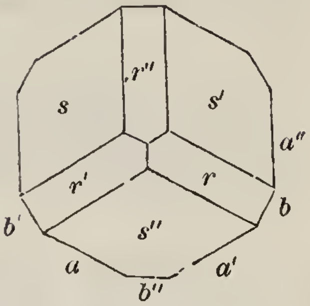


FIG. 335.



Combinations. *rb*, *roa*, *rsab*. Cleavage. *o* perfect, *b* and *r* traces. Fracture imperfect conchoidal. Semi-transparent… translucent. Lustre vitreous, inclining to resinous. Colourless, white, yellow, brown, when impure. Streak white. Brittle. H = 5·5. G = 3·89…4·18.

Becomes opaque before the blowpipe, and melts with difficulty on the edges. Is decomposed by hydrochloric acid, leaving a jelly of silica. Is in a great measure soluble in a solution of caustic potash.

$\dot{Z}n^2\ddot{S}i$, silica 27·53, oxide of zinc 72·47.

Analyses of willemite *a* from Franklin, *b* from Sterling (troostite), both by Vanuxem and Keating, *c* from Moresnet by Levy, *d* from Stolberg, *e* from Stolberg, compact, both by Monheim:—

	a	*b*	*c*	*d*	*e*
Silica	25·00	25·44	28·03	26·90	26·53
Oxide of zinc	71·33	68·06	70·88	72·91	69·06
Red oxide of iron . .	0·67	6·50	0·78	0·35	4·36
Oxide of manganese .	2·66		—	$\dot{C}a$	0·41
Magnesia	—	—	—	—	0·13
Loss by ignition . . .	—	—	0·31	$\ddot{C}$	0·04

Analyses of willemite *f* from Aix-la-Chapelle, *g* from Franklin, both by Delesse, *h* from New Jersey (troostite) by Hermann, *i* from Upper Silesia by Rosegarten:—

	f	*g*	*h*	*i*
Silica	27·28	27·40	26·80	27·34
Oxide of zinc	72·37	68·83	60·07	70·82
Protoxide of iron	0·35	0·87	—	1·81
Protoxide of manganese . .	—	2·90	9·22	—
Magnesia	—	—	2·91	—
Loss by ignition	—	—	1·00	—

In attached crystals, reniform, and compact.

Is found at Moresnet near Liege, Stolberg near Aix-la-Chapelle, Raibel in Carinthia, Kucsaina in Servia, Franklin in New Jersey. The figure of troostite (combination *rsab*), which till lately was supposed to consist principally of silicate of protoxide of manganese, is given on Breithaupt's authority. His observations make $rr' = 50°$ nearly.

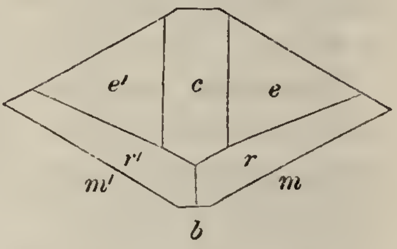
182. GADOLINITE.—Gadolinite; Phillips, Hauy. Hemi-prismatisches Melan-Erz; Mohs. Gadolinit; Hausmann, Haidinger.

Prismatic. 011,010=25° 40′; 101,001=50° 30′; 110,100=59° 45′.

b 010, *c* 001, *e* 104, *m* 110, *r* 111. *r* is hemihedral with parallel faces.

bc	90°	0′
ec	16	52
mb	30	15
mm′	60	30
rc	67	27
rm	22	33

FIG. 336.



Cleavage none perceptible. Fracture conchoidal...uneven. Translucent on the edges...opaque. Lustre vitreous, inclining to resinous. Black, seldom red. The black varieties greenish by transmitted light. Streak greenish-grey. H = 6·5. G = 4·2 ...4·4. Sometimes magnetic.

Infusible, or fusible with difficulty before the blowpipe. Some varieties from Hitteröe glow brightly when heated, and their specific gravity is increased by ignition from 4·35 to 4·63; others merely intumesce. Soluble readily in borax, and partially in salt of phosphorus, forming a glass coloured by iron. Completely decomposed by hydrochloric acid leaving a jelly of silica. After ignition is decomposed with difficulty.

Analyses of gadolinite from Hitteröe *a*, *b* by Scheerer, of glassy gadolinite from Ytterby *c*, *d*, *e*, *f* by Berlin:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	25·78	25·59	24·65	24·65	24·86	24·85
Yttria	45·67	44·96	49·60	51·38	48·32	51·46
Oxide of cerium .	1·81	—	7·64	7·99	7·41	5·24
Ox. lanthanium .	4·75	6·33				
Protoxide of iron .	11·68	12·13	15·03	14·69	14·80	13·01
Glucine	9·57	10·18	2·13	traces	3·50	4·80

	a	*b*	*c*	*d*	*e*	*f*
Lime	0·34	0·23	0·46	1·29	0·67	0·50
Magnesia	—	—	traces		0·67	1·11
Protox. man.	—	—				
Red ox. iron	1·28	—	—	—	—	—

Crystallized, massive, in rounded imbedded grains; often covered with a yellow crust.

Is found in granite, gneiss and syenite, at Ytterby near Stockholm, Finbo, Broddbo and Kararfvet near Fahlun, Brevig and Hitteröe, Bornholm, Disko, Ceylon, in trap near the town of Galway in Ireland.

The angles given above were deduced from measurements of a crystal in Mr. Brooke's collection made with the reflective goniometer. On account of the imperfection of the faces of the crystal, they must be regarded as rough approximations only. According to Breithaupt the crystals are pseudomorphous.

It is doubtful whether the form is hemihedral prismatic or oblique. The only crystals we have seen are too rough for exact measurement; we, therefore, retain it in the prismatic system, in accordance with the views of W. Phillips, and leave it to future observation to determine in which system it ought to stand.

183. TSCHEFFKINITE.—Tschewkinit; Hausmann. Tscheffkinit; Haidinger.

Fracture flat conchoidal. Almost opaque. Lustre vitreous, bright. Velvet black; by transmitted light brown. Streak dark brown. H = 5·3. G = 4·508...4·549.

Before the blowpipe on the first application of heat glows, intumesces, turns brown, and at last melts into a black globule. In powder melts readily in borax into a clear glass slightly coloured by iron. Before ignition gelatinizes in hydrochloric acid.

Mean of six analyses by H. Rose:—

Silica	21·04
Titanic acid	20·17
Lime	3·50
Magnesia	0·22
Protoxide of manganese	0·83
Protoxide of iron	11·21
Oxides of cerium, lanthanium, didymium	47·29
Potash and soda	0·12

The excess of 4·38 per cent. arises from the conversion of the protoxide of cerium into oxide during the analysis. The silica, when boiled with a solution of carbonate of soda, left behind a remainder of from 2·09 to 4·29 per cent. The titanic acid appears to contain glucine, alumina and yttria.

Is found with felspar in the Ilmen mountains near Miask.

184. ILVAITE.—Lievrite; Phillips. Fer calcaréo-siliceux; Hauy. Diprismatisches Melan-Erz; Mohs. Ilvait; Hausmann. Lievrit; Haidinger.

Prismatic. 011,010=56° 20′; 101,001=24° 31′; 110,100=55° 36′.

a 100, *b* 010, *c* 001, *r* 011, *w* 031, *e* 201, *n* 102, *m* 110, *s* 210, *t* 310, *v* 120, *d* 410, *o* 111, *x* 121. *n* truncates the edge *ec*; *v* the edge *mb*; *t*, *d* truncate the edge *sa*, *x* is in the zone *ob*.

rc	33°	40′	*da*	20°	3′	*oc*	38°	55′
wc	63	25	*ta*	25	57	*or*	20	47
bc	90	0	*sa*	36	8	*oo′*	41	34
rr′	67	20	*ma*	55	36	*oo″*	62	26
ww′	126	50	*va*	71	6	*om*	51	5
nc	12	51	*ba*	90	0	*xc*	54	38
ec	42	23	*ss′*	107	44	*xx′*	30	38
ac	90	0	*mm′*	68	48	*xx″*	100	58
ee′	84	45						

FIG. 337.

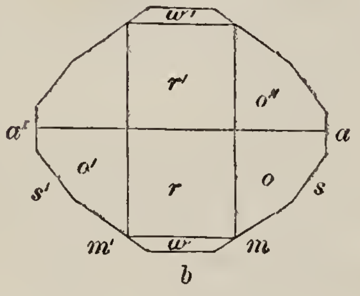
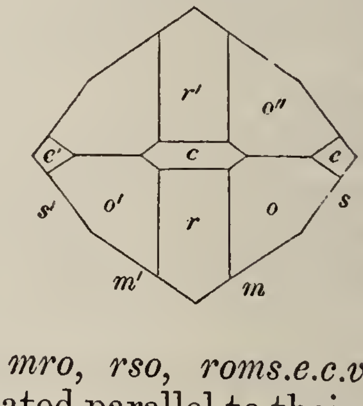


FIG. 338.



Combinations. *om*, *ot*, *rm*, *mso*, *mro*, *rso*, *roms.e.c.v.ve.ce*, *rowbmsa*. The faces *a*, *t*, *s*, *m*, *v*, *b* striated parallel to their intersections with each other; *o*, *r* striated parallel to their common intersection. Cleavage. *a*, *c*, *r*, *m*, the two former more distinct than the two latter. Fracture imperfect conchoidal...uneven. Opaque. Lustre imperfect metallic inclining to resinous. Black, inclining to grey, brown and green. Streak black, sometimes inclining to green. Brittle. H = 5·5...6·0. G = 3·989...4·015. Feebly magnetic. Is a good conductor of electricity.

Before the blowpipe melts readily into a black magnetic globule. Imparts the colour of iron to borax and salt of phosphorus. With salt of phosphorus leaves a skeleton of silica. In warm hydrochloric acid is easily and completely dissolved into a yellowish transparent jelly.

$\dddot{\bar{\mathrm{F}}}\mathrm{e}\ddot{\mathrm{Si}} + 2\dot{\mathrm{R}}^{2}\ddot{\mathrm{Si}}$, when $\dot{\mathrm{R}}$ is lime and protoxide of iron.

Analyses of ilvaite from Elba *a* by Stromeyer, the proportions of $\dot{\mathrm{Fe}}$ and $\dddot{\bar{\mathrm{Fe}}}$ by v. Kobell, *b*, *c*, *d*, *e*, *f* by Rammelsberg. In *b* the whole of the iron is estimated as protoxide; in *c* the amount of red oxide of iron only, and in *d*, *e*, *f* the quantities of $\dot{\mathrm{Fe}}$ and $\dddot{\bar{\mathrm{Fe}}}$ respectively are determined.

	a	*b*	*c*	*d*	*e*	*f*
Silica	29·28	29·83	29·10	—	—	—
Red oxide of iron .	23·00	—	22·24	24·58	22·80	21·79
Protoxide of iron . .	31·90	52·68	—	30·73	33·07	34·20
Lime	13·78	12·44	11·00	—	—	—
Oxide of manganese .	1·59	1·51	—	—	—	—
Alumina	0·61	—	—	—	—	—
Water	1·27	—	—	—	—	—

In attached crystals; granular and fibrous masses.

Is found at Rio la Marina and Cape Calamita in Elba, in Bredgang mine at Fossum near Skeen in Norway, Kupferberg in Silesia, Reschitz in Moravia, Rhode-island, Siberia, Greenland.

Ilvaite is liable to decomposition, being converted into an earthly substance containing hydrate of red oxide of iron.

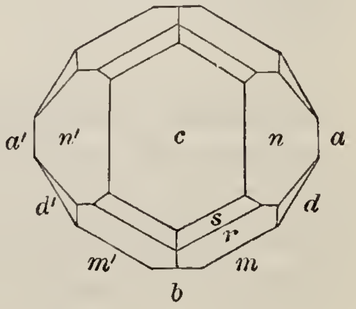
185. CORDIERITE.—Iolite; Phillips. Cordierite; Hauy. Prismatischer Quarz; Mohs. Dichroit; Hausmann. Cordierit; Haidinger.

Prismatic. 011,010=46° 26′; 101,001=29° 11′; 110,100=59° 35′.

a 100, *b* 010, *c* 001, *n* 101, *m* 110, *d* 310, *r* 111, *s* 112, *o* 311.

nc	29° 11′		*rc*	47° 48′	
ac	90 0		*sa*	75 51	
nn′	58 22		*sb*	65 23	
da	29 35		*oa*	39 28	
ma	59 35		*ra*	67 58	
ba	90 0		*rb*	50 18	
dd′	120 50		*ob*	64 1	
mm′	60 50		*oc*	62 34	
sc	28 53				

FIG. 339.



Combinations. *cmdab*, *crmb..a.d*, *cromd.ab*, *csromdb..n.a.* Cleavage. *a*, imperfect. Faces of union *c*. Fracture conchoidal. Transparent...translucent. Lustre vitreous, brightest on surfaces of fracture, sometimes inclining to resinous. R = 1·544. Blue of various shades, inclining frequently to grey or black. Exhibits pleochroism. One variety is dark blue when viewed with the naked eye in a direction perpendicular to *c*, greyish-white perpendicular to *b* and yellowish-white perpendicular to *a*. Light transmitted parallel to *a* and polarized in a plane parallel to *a* is dark blue, light parallel to *b* and polarized in a plane parallel to *b* is blueish-white, light parallel to *c* and polarized in a plane parallel to *c* is yellowish-white. The optic axes are in a plane parallel to *a*, and make angles of 31° 25′ with a normal to *c*. A light stripe between two dark spots may be seen on looking through a crystal in the direction of either optic axis. Streak white. H = 7·0...7·5. G = 2·600...2·718.

Melts with difficulty on the edges before the blowpipe. Soluble with difficulty in borax and salt of phosphorus, leaving a skeleton of silica in the latter. With a small quantity of soda yields a dark grey slag, with a larger quantity intumesces and becomes infusible. Imperfectly decomposed by acids.

$\dddot{\mathrm{Al}}\ddot{\mathrm{Si}}^3 + 2\dot{\mathrm{Mg}}\ddot{\mathrm{Si}}$, a considerable portion of the $\dot{\mathrm{Mg}}$ being replaced by $\dot{\mathrm{Fe}}$.

Analyses of cordierite *a* from Bodenmais, *b* from Simiutak in Greenland, *c* from Orijerfvi in Finland (steinheilite), *d* from Fahlun (hard fahlunite), all by Stromeyer, *e* from Orijerfvi by v. Bonsdorff, *f* from Connecticut by Thomson:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	48·35	49·17	48·54	50·25	49·95	49·62
Alumina	31·71	33·11	31·37	32·42	32·88	28·72
Magnesia	10·16	11·45	11·30	10·85	10·45	8·64
Protoxide of iron . .	8·32	4·34	5·69	4·00	5·00	11·58
Protox. mangan. . .	0·33	0·04	0·70	0·68	0·03	1·51
Water	0·59	1·20	1·69	1·66	1·75	$\dot{\mathrm{Ca}}$ 0·23

Analyses of cordierite *g* from Orijerfvi, *h* from Finspang in Eastgothland, G = 2·64, *i* from Brunhult in Südermanland (G = 2·61), all by Schütz, *k* from Haddam in Connecticut, *l* from Unity in New Hampshire, both by Jackson, *m* from Krageröe in Norway, mean of two analyses by Scheerer:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	48·9	48·6	49·7	48·35	48·15	50·44
Alumina	30·9	30·5	32·0	32·50	32·50	32·95
Protoxide of iron . .	6·3	10·7	6·0	6·00	7·92	—
Magnesia	11·2	8·2	9·5	10·00	10·14	12·76
Protox. mang. . . .	0·3	0·1	0·1	0·10	0·28	—
Lime	—	—	0·6	—	—	1·12
Not decomposed . . .	1·6	0·2	0·6	—	$\overset{\cdots}{\mathrm{Fe}}$	1·07
Loss by ignition . .	1·9	1·5	2·1	3·10	0·50	1·02

In imbedded crystals and granular masses, usually in gneiss.

Is found in crystals at Nijar on Cabo de Gata in Spain, in crystals and massive at Bodenmais in Bavaria, near the Lake of Laach, Orijerfvi in Finland, Tvedestrand near Brevig in Norway, Fahlun in Sweden, Greenland, Siberia, North America, in rolled pebbles in Ceylon.

Cordierite decomposes readily. At Gloria near Rio Janeiro it is found unaltered, slightly decomposed, and converted into a substance like serpentine. The substances which have been called pinite, gieseckite, killinite, fahlunite, bonsdorffite, esmarkite, aspasiolite, pyrargillite, chlorophyllite, gigantolite, praseolite, iberite, weissite, oosite, are supposed by Dana, Haidinger, Blum, Bischoff, to be cordierite which has been more or less altered.

186. IDOCRASE.—Idocrase; Phillips, Hauy. Pyramidaler Granat; Mohs. Idocras; Hausmann, Haidinger.

Pyramidal. 010,001 = 28° 9′.

a 100, *c* 001, *e* 101, *g* 201, *m* 110, *f* 210, *h* 310, *n* 113, *y* 112, *u* 111, *w* 221, *t* 331, *r* 441, *z* 211, *o* 421, *i* 312, *s* 311, *x* 411, *v* 511.

ha	18°	26′	*tc*	66°	14′	*zc*	50°	7′
fa	26	34	*rc*	71	43	*oc*	67	20
ma	45	0	*mc*	90	0	*xc*	65	37
aa′	90	0	*va*	22	58	*vc*	69	53
mm′	90	0	*xa*	27	55	*ua*	64	45
ec	28	9	*sa*	35	15	*za*	46	40
gc	46	57	*ae′*	90	0	*ia*	52	13
ac	90	0	*ic*	40	14	*na*	80	3
nc	14	10	*sc*	59	25	*ya*	75	31
yc	20	44	*oa*	34	24	*ta*	49	41
uc	37	7	*wa*	53	51	*ra*	47	49
wc	56	33	*az′*	69	56	*em*	70	31

gm	58°	54′	*uu′*	50°	31′	*zz″*	40°	6′
sa′	74	12	*ww′*	72	19	*ss″*	31	36
xa′	77	14	*tt′*	80	39	*ss′*	45	15
va′	79	23	*rr′*	84	21	*oo″*	48	44
ia′	78	13	*ee′*	38	59	*oo′*	33	56
oa′	65	38	*gg′*	62	13	*ii″*	23	34
nn′	19	55	*zz′*	28	5	*ii′*	33	35
yy′	28	59						

FIG. 340.

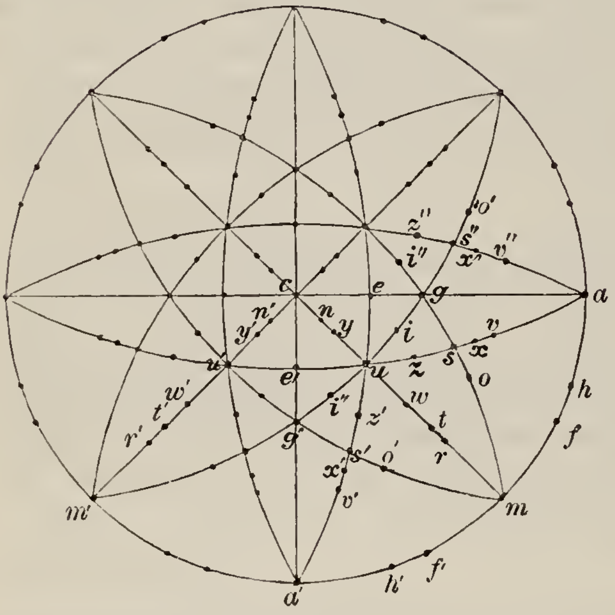


FIG. 341.

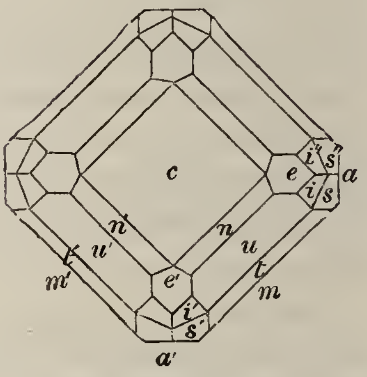
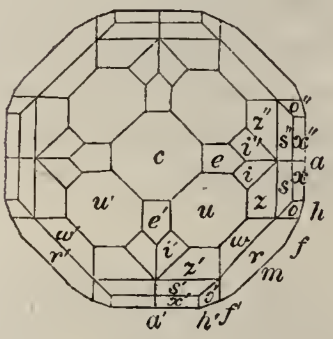


FIG. 342.



Combinations. *umah*, *cma..h.f*, *cuma.e.h.s.r*, *cuwmaf*, *ceuma..n.y.i.z.s.t*, *cnioustma*, *couizwsvorhfma*, *cneuizwhtovtfma*. *c* often uneven and curved. The faces *a*, *h*, *f*, *m* striated parallel to their intersections with each other. Cleavage. *m*, *a* not very distinct; *c*, less distinct. Fracture imperfect conchoidal, uneven. Transparent...translucent. Lustre vitreous, inclining to resinous. Various shades of green passing into yellow, brown and black. Inclining to yellow in a direction perpendicular to *c*, and to green in directions parallel to *c*. In a variety from Piedmont light transmitted through the crystal parallel to *c* is oil-green when polarized in a plane perpendicular to *c*, and grass-green when polarized in a plane parallel to *c*. Streak white. H = 6·5. G = 3·35...3·45.

Before the blowpipe melts easily with intumescence into a yellowish-green or brown glass. With borax and salt of phosphorus fuses into a glass coloured by iron; with the latter yields a skeleton of silica. Is imperfectly decomposed by hydrochloric acid. After fusion completely decomposed by hydrochloric acid forming a jelly of silica. Cyprine in the inner blowpipe flame melts into a red glass. With borax fuses into a green glass. With soda yields metallic copper.

According to Magnus after fusion G = 2·95. According to Varrentrapp fusion reduces G from 3·346 to 2·929...2·941.

$\dot{C}a^3\ddot{S}i^2 + \dddot{Al}\ddot{S}i$, a portion of the $\dot{C}a$ being replaced by $\dot{M}g$, $\dot{F}e$, $\dot{M}n$, and part of the $\dddot{Al}$ by $\dddot{\bar{F}e}$.

In the three analyses by Hermann the quantities of oxygen in the bases $\dot{R}$, $\ddot{\bar{R}}$ and in the $\ddot{S}i$ are as numbers 3, 2, 5 nearly.

Analyses of idocrase *a* from Egg near Christiansand, *b* from Cziklowa in the Banat, *c* from Vesuvius, *d* from Slatoust, all by Magnus, *e*, *f* from Slatoust by Varrentrapp:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	37·66	38·52	37·36	37·18	37·55	37·84
Alumina	17·70	20·06	23·53	18·11	17·88	17·99
Lime	31·90	32·41	29·68	35·79	35·56	35·18
Protoxide of iron . .	6·49	3·42	3·99	4·67	6·34	6·45
Magnesia	4·54	2·99	5·21	0·77	2·62	2·81
Protox. of manganese	0·50	0·02		1·50	—	—

Analyses of idocrase *g* from Vesuvius, *h* from Piedmont, *i* from the valley of Sass, all by Karsten, *k* from Monzoni by v. Kobell, *l* from Göckum by Berzelius, *m* from Frugard by Nordenskiöld:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	37·50	39·25	38·40	37·64	36·00	38·53
Alumina	18·50	18·10	18·05	15·42	17·50	17·40
Red oxide of iron .	6·25	($\dot{N}a$	0·90)	—	5·25	—
Protoxide of iron . .	—	4·30	3·10	6·42	—	3·90
Lime	33·71	33·85	36·72	38·24	37·65	27·70
Magnesia	3·10	2·70	1·50	—	2·52	10·60
Protox. of manganese	0·10	0·75	0·65	($\dot{H}$	0·36)	0·33

Analyses of idocrase *n* from a place to the east of Kongsberg by Rammelsberg, *o* from the Wilui river in Siberia, G = 3·375, *p* from Achmatowsk in the district of Slatoust, G = 3·40, *q* from Poläkowsk in the district of Slatoust, G = 3·42, all by Hermann, *r* of a partially decomposed variety from Haslau near Eger by Karsten, *s* from Ala by v. Kobell:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	37·24	38·23	37·62	38·19	39·70	34·85
Alumina	16·80	14·32	13·25	14·35	18·95	20·71
Red oxide of iron . .	7·21	5·34	7·12	5·26	—	—

	n	*o*	*p*	*q*	*r*	*s*
Protoxide of iron . .	—	1·03	0·60	0·61	2·90	5·40
Lime	33·60	34·20	36·43	32·69	34·88	35·61
Magnesia	5·26	6·37	3·79	6·20	—	—
Protox. of manganese	—	0·50	0·50	2·10	0·96	—
Loss by ignition . .	0·22	$\ddot{C}$	0·70	$\dot{N}a$	2·10	—

A green or blue variety from Tellemarken in Norway (cyprine) contains some oxide of copper.

In attached and imbedded crystals and columnar masses.

Is found on Monte Somma in blocks of dolomite, at the junction of the rivers Achtaragda and Wilui near the Lake Baikal, Slatoust in the Ural, Kamtschatka, Monzoni in the Fassathal, Schwarzenstein in the Zillerthal, Firudo on St. Gotthardt, in veins in serpentine at Testa Chiarva on the Mussa Alp in Piedmont, at Christiania, Egg near Christiansand, and Souland (the blue variety, cyprine) in Norway, Haslau near Eger in Bohemia, Orawitza in the Banat in limestone, Gökum in Sweden, Frugard in Finland, many places in the Pyrenees, Auerbach in Baden, Schwarzenberg in Saxony, Kilranelagh in Wicklow and the county of Donegal in Ireland, in Spain, and in North America.

187. GARNET.—Garnet; Phillips. Grenat; Hauy. Dodecaedrischer Granat; Mohs. Granat; Hausmann, Haidinger.

Cubic.

a 100, *d* 011, *e* 210, *n* 211, *x* 233, *s* 231, *u* 341.

aa′	90° 0′		*ee″*	36° 52′		*xn′*	16° 47′
nn′	33 33		*ed*	18 26		*sa′*	36 42
nn,	48 12		*en′*	24 6		*sn′*	10 54
dd′	60 0		*na*	35 16		*sd″*	19 6
da′	45 0		*nd′*	30 0		*ua′*	38 20
dn	54 44		*xd*	25 13		*un′*	16 6
ea′	26 34		*xn*	29 31		*ud″*	13 54

FIG. 343.

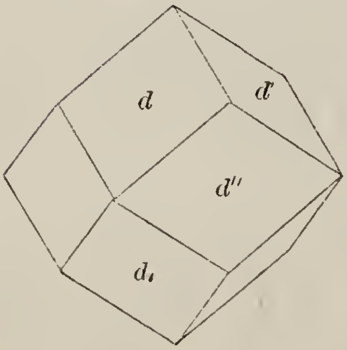


FIG. 344.

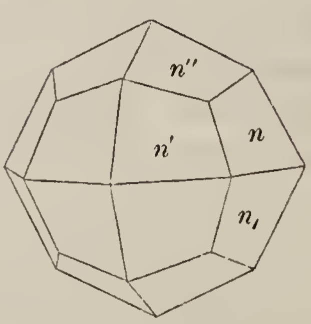


FIG. 345.

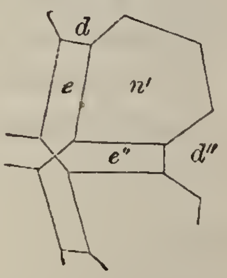


FIG. 346.

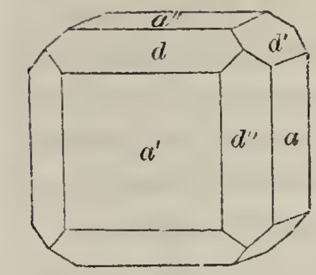


FIG. 347.

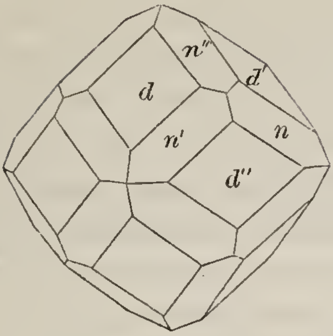
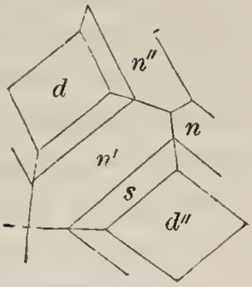


FIG. 348.



Forms and combinations. *d*, *n*, *ad*, *dn*, *dne*, *dns*, *dnes*. *a* rough. The faces *n*, *s* striated parallel to their intersection with *d*; *d* striated parallel to their intersections with the faces *a*. Cleavage. *d*, obtained with difficulty. Fracture conchoidal, more or less perfect...uneven. Transparent...opaque. Lustre vitreous inclining to resinous. $\mu = 1{\cdot}759$. Red, brown, yellow, white, green, black. Streak white...grey. H = 6·5...7·5. G = 3·1...4·3.

Before the blowpipe melts easily into a glass, which when the variety contains much iron is black or grey, in other cases is green or brown. Soluble in borax and salt of phosphorus forming a glass coloured by iron or manganese; with the latter leaves a skeleton of silica. Imperfectly soluble in hydrochloric acid. After fusion is easily decomposed by hydrochloric acid forming a jelly of silica.

A garnet (G = 3·6), and idocrase (G = 3·45), were found by Magnus to have the same composition. After fusion they had the same lustre, hardness and specific gravity (G = 2·957).

Analyses of the varieties represented nearly by the formula $\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}^2 + \overset{\cdots}{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}$, H = 6·5...7·0, G = 3·44...3·62. Greyish, yellowish-white, green varieties having the forms *d*, *n* (grossular), *a* from the Wilui by Karsten, *b* from the Wilui, *c* from Tellemarken, both by Trolle-Wachtmeister, *d* from Slatoust, G = 3·504, by Croft; red and yellow varieties (essonite, cinnamonstone), *e* from Ceylon by Gmelin, *f* from Malsjö in Wermland by Arfvedson, *g* from Kimito by Nordenskiöld:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Silica . .	38·25	40·55	39·60	36·86	40·01	41·87	41·21
Alumina .	19·35	20·10	21·20	24·19	23·00	20·57	24·08
Red ox. iron	7·33	5·00	—	—	3·67	3·93	7·02
Protox. iron	—	—	2·00	—	—	—	—
Lime . .	31·75	34·86	32·30	37·15	30·57	33·94	24·76
Magnesia .	2·40	—	—	(potash 0·59)		0·39	0·92
Protox. man.	0·50	0·48	3·15	(volatile 0·33)			

Analyses of varieties having the forms *a*, *d*, *n*, *e*, *h* reddish-yellow garnet from St. Gotthardt by Karsten, *i*, brownish-red garnet from Friedberg in Silesia by Karsten, *k* reddish-brown garnet from Vesuvius by Trolle-Wachtmeister; of brown garnet having the forms *d*, *n*, H = 7·0, G = 3·429...3·432 (calophonite), *l* from Norway by Richardson; of black magnesian garnet consisting principally of $\dot{Mg}^3\ddot{Si}^2 + \overline{\dddot{Al}}\ddot{Si}$, having the forms *d*, *n*, H = 6·5 ...7·0, G = 3·157, *m* from Arendal by Trolle-Wachtmeister; of red...brown manganesian garnet having the form *n*, H = 7·0... 7·5, G = 3·666...3·775, represented by the formula $\dot{Mn}^3\ddot{Si}^2 + \overline{\dddot{Al}}\ddot{Si}$, a large portion of the $\dot{Mn}$ being replaced by $\dot{Fe}$, *n* from North America by Seybert:—

	h	*i*	*k*	*l*	*m*	*n*
Silica	37·82	36·55	39·93	37·60	42·45	35·83
Alumina	19·70	18·75	13·45	14·40	22·47	18·06
Red oxide of iron . .	5·95	6·61	10·95	13·35	—	—
Lime	31·35	31·44	31·66	27·80	6·53	—
Magnesia	4·15	4·20	—	6·55	13·43	—
Protoxide of iron . .	—	—	3·55	—	9·29	14·93
Protox. mangan. . .	0·15	1·70	1·40	($\dot{H}$ 1·00)	6·27	30·96

Red and brown varieties, transparent...translucent on the edges, having the faces *d*, *n*, H = 7·0...7·5, G = 3·95...4·29, represented nearly by the formula $\dot{Fe}^3\ddot{Si}^2 + \overline{\dddot{Al}}\ddot{Si}$ (almandine), *o* from the Zillerthal by Karsten, *p* from Fahlun by Hisinger, *q* from Garpenberg in Sweden by W. Wachtmeister, *r* from Brena in Südermanland by Bahr, *s* from the Greiner in the Zillerthal, *t* from Hungary, both by v. Kobell:—

	o	*p*	*q*	*r*	*s*	*t*
Silica	39·62	39·66	39·42	37·16	39·12	40·56
Alumina	19·30	19·66	20·28	19·30	21·08	20·61
Red oxide of iron . .	—	—	—	—	6·00	5·00
Protoxide of iron . .	34·05	39·68	24·82	37·65	27·28	32·70
Lime	3·28	—	2·63	0·90	5·76	—
Magnesia	2·00	—	3·69	2·03	—	—
Protox. mangan. . .	0·85	1·80	7·51	3·19	0·80	1·47

Analyses of almandine *u* from Ohlapian, *v* from Greenland, both by Karsten, *w* from Engsö in Sweden, *x* from Hallandsas in Sweden, *y* from Hallandsas, *z* from New York, all by Trolle-Wachtmeister:—

	u	*v*	*w*	*x*	*y*	*z*
Silica	37·15	39·85	40·60	41·00	42·00	42·51
Alumina	18·08	20·60	19·95	20·10	21·00	19·15
Protoxide of iron . .	31·30	24·85	33·93	28·81	25·18	33·57
Lime	0·36	3·51	—	1·50	4·98	1·07
Magnesia	10·15	9·93	—	6·04	4·32	—
Protox. mangan. . .	0·30	0·46	6·69	2·88	2·38	5·49

Analyses of the varieties of garnet represented by the formula $\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i}^2 + \dddot{\bar{\mathrm{Fe}}}\dddot{\mathrm{S}}\mathrm{i}$, part of the $\dot{\mathrm{C}}\mathrm{a}$ being replaced by $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{M}}\mathrm{n}$, and part of the $\dddot{\bar{\mathrm{Fe}}}$ by $\dddot{\bar{\mathrm{A}}}\mathrm{l}$; brown, green, yellow, having the faces *d*, *n*, *e*, *s*, H = 7·0, G = 3·65...3·85 (aplome), *α*, *β* from Sahla in Sweden by Bredberg, *γ* from Lindbo in Westmanland by Hisinger; black, having the faces *d*, *n* nearly opaque, in thin fragments translucent, green by transmitted light, G = 3·74... 3·79 (melanite), *δ* from Frascati by Vauquelin, *ε* by Karsten, *ζ* from Beaujeux by Ebelmen:—

	α	*β*	*γ*	*δ*	*ε*	*ζ*
Silica	36·62	36·73	37·55	34·0	34·60	36·45
Alumina	7·53	2·78	—	6·4	4·55	2·06
Red oxide of iron . .	22·18	25·83	31·35	25·5	28·15	29·48
Lime	31·80	21·79	26·74	33·0	31·80	30·76
Magnesia	1·95	12·44	—	—	0·65	0·06
Protox. mangan. . .	—	—	7·40	—	—	0·28
Loss by ign.	—	—	—	—	—	0·96

In attached and imbedded crystals, granular, massive, in granite, gneiss, mica slate, chlorite slate, hornblende rock, serpentine, lava, rarely in limestone.

The transparent red garnet (almandine) is found in the sand of rivers and in alluvial soil in Pegu, Ceylon, Hindostan, the Brazils; in Bohemia in alluvium near Collin, in gneiss at Zbislau and many places near Czaslau. Opaque crystals are found in the Tyrol in the Oetzthal and on the Greiner, in Carinthia, Styria, in Switzerland at Airolo, Canaria, Maggia; Hungary, Sweden, Norway, Scotland, Spain, Greenland, North America. The common garnet is found in Saxony at Breitenbrunn, Berggieshübel, Geier, Schwarzenberg; in Norway at Drammen and Arendal; in Sweden at Broddbo, Finbo, Fahlun, Langbanshytta, Finland, in the Banat at Orawitza; in Hungary at Dobschau and Rezbanya, in Stiria at Saldenhofen, in the Tyrol at Monzoni in Fassathal and Schneeberg; Moravia, Silesia, Siberia; in granular limestone at Haslau near Eger in Bohemia. The granular brown variety (calophonite) is found at Arendal and in North America; the light green variety (grossular) in serpentine with idocrase on the river Wilui in Kamtschatka; the black variety (melanite) in volcanic rocks on Monte Somma in matter ejected by Vesuvius, Frascati, Albano near Rome, the Breisgau; in beds in the older rocks at Arendal in Norway; in granular limestone in the Pic d'Ereslids near Barèges in the Pyrenees. The honey-yellow garnet (topazolite) in veins in serpentine on the Mussa Alp in Piedmont. The reddish-yellow garnet (essonite) in Ceylon, Egypt, Pargas in Finland, the Mussa Alp in Piedmont.

Pyrope appears to be a variety of garnet having the forms *a*, *d*, in which, according to Moberg, protoxide of chrome forms part of the base $\dot{\mathrm{R}}$. The faces *a* convex and rough. No cleavage observable. Fracture conchoidal. Transparent...semi-transparent. Lustre vitreous. $\mu = 1{\cdot}792$. Dark hyacinth-red...blood-red. H = 7·5. G = 3·699...3·78.

When heated becomes black and opaque; on cooling yellowish and then red. Fusible with difficulty before the blowpipe into a black glass. With borax and salt of phosphorus melts into a chrome-green glass. After fusion is partially decomposed by hydrochloric acid. In powder, when heated with access of air, becomes brick-red. Not acted upon by acids.

Analyses of pyrope *a* from Meronitz in Bohemia by Trolle-Wachtmeister, *b* from the Stiefelberg in Bohemia by v. Kobell, *c* from Bohemia by Moberg :—

	a		*b*		*c*
Silica	43·70		42·08		41·35
Alumina	22·40		20·00		22·35
Red oxide of iron	—		1·51		—
Protoxide of iron	11·48		9·10		9·94
Lime	6·72		1·99		5·29
Magnesia	5·60		10·20		15·00
Protoxide of manganese	3·68	$\dddot{\mathrm{\bar{M}n}}$	0·32		2·59
$\dddot{\mathrm{Cr}}\dddot{\mathrm{\bar{C}r}}$	6·52	$\dddot{\mathrm{Cr}}$	3·01	$\dot{\mathrm{Cr}}$	4·18

In indistinct crystals; usually in rounded grains.

Is found in serpentine at Zöblitz and Greifendorf in Saxony, in boulders and alluvium in Bohemia at Meronitz, Gitschin, Rowensko, Neu Pakka, Podsedlitz, Trziblitz; also in Ceylon.

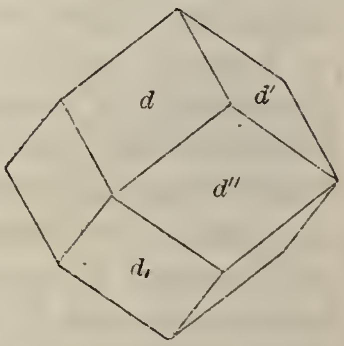
188. UWAROWITE.—Uwarowit; Mohs, Hausmann, Haidinger.

Cubic.

d 011.

dd′ 60° 0′

FIG. 349.



Fracture imperfect conchoidal, splintery. Translucent...translucent on the edges. Lustre vitreous. Emerald-green. Streak greenish-white. H = 7·5...8·0. G = 3·4184.

Infusible before the blowpipe. With borax melts slowly into a transparent chrome-green glass.

$\dot{\mathrm{Ca}}^3\ddot{\mathrm{Si}}^2 + \dddot{\mathrm{\bar{C}r}}\ddot{\mathrm{Si}}$, part of the $\dot{\mathrm{Ca}}$ being replaced by $\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mg}}$, and part of the $\dddot{\mathrm{\bar{C}r}}$ by $\dddot{\mathrm{\bar{A}l}}$.

Analyses *a* by Komonen, *b* by A. Erdmann, *c* by Damour:—

	a	*b*	*c*
Silica	37·11	36·93	35·57
Alumina	5·88	5·68	6·25
Oxide of chrome . .	22·54	21·84	23·45
Red oxide of iron . .	—	1·96	—
Protoxide of iron . .	2·44	—	—
Lime	30·34	31·63	33·22
Magnesia	1·10	1·54	—
Water	1·01	—	—

In attached crystals and massive.

Is found at Saranowskaja near Bissersk and at Kyschtimsk in the Ural.

189. **EUCLASE.**—Euclase; Phillips, Hauy. Prismatischer Smaragd; Mohs. Euklas; Hausmann, Haidinger.

Oblique. 101,100=49° 17′; 111,010=75° 53′·5; 101,001=21° 50′.

a 100, *b* 010, *c* 001, *v* 012, *m* 101, *s* 110, *l* 320, *k* 210, *q* 430, *d* 111, *n* $\bar{1}11$, *f* 131, *e* 331, *o* $\bar{1}21$, *r* $\bar{3}11$, *u* $\bar{3}21$, *i* $\bar{3}41$.

ma	49°	17′	*db*	75°	54′	*ns*	88°	25′
ca	71	7	*mb*	90	0	*ns′*	72	10
vb	81	5	*ob*	56	52	*os*	80	7
cb	90	0	*nb*	71	55	*es*	25	28
sb	57	25	*ib*	49	52	*ds*	48	22
qb	64	24	*ub*	67	10	*fs*	40	16
lb	66	55	*rb*	78	6	*nba*	100	1
kb	72	17	*eb*	65	8	*rba*	140	32
ab	90	0						
fb	53	0						

FIG. 350.

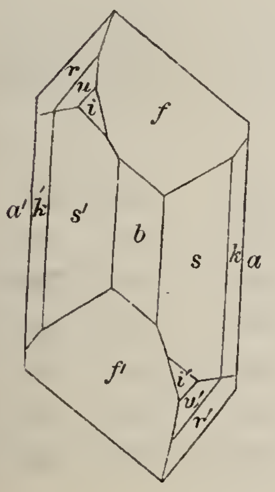
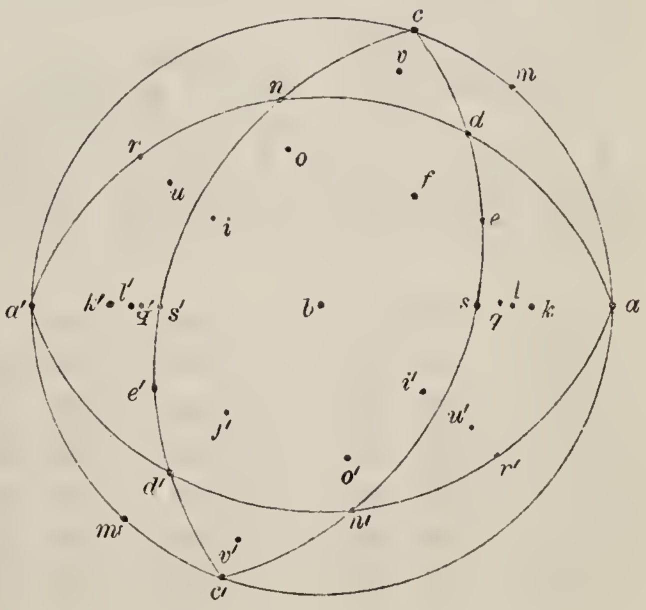


FIG. 351.



Combinations. *abskfr.u*, *askfrui..n.e*, *cdfenoruiklsb*, *drenouihlsb*, *vdfenoriuklsb*. The faces in the zone *ab* striated parallel to their intersections with each other. Cleavage. *b*, very perfect and easily obtained; *m*, *a* less distinct. Fracture conchoidal. Transparent...semi-transparent. Lustre vitreous. R = 1·663, 1·643. Green, yellow, blue, very pale. Streak white. H = 7·5. G = 3·0...3·1.

When heated strongly before the blowpipe intumesces and, in thin splinters, melts into a white enamel. Dissolves in borax and salt of phosphorus with intumescence. Is not acted upon by acids.

$\dddot{A}l\ddot{S}i^3 + 6\dot{G}^2\ddot{S}i$, silica 43·68, alumina 32·40, glucine 23·92.

Analysis by Berzelius :—

Silica	43·22
Alumina	30·56
Red oxide of iron . . .	2·22
Glucine	21·78
Oxide of tin . . .	0·70

In attached and isolated crystals.

Is found in chlorite slate at Boa Vista and Capao near Villa-Rica in the Brazils, imbedded in mica and fluor at Trumbull in Connecticut, Peru, and is said to have been found in Siberia near the Baikal.

The forms of euclase are frequently hemihedral. It has been supposed that they are always hemihedral. In a crystal in the Humian collection in Cambridge corresponding faces occur on both sides of the zone *amc*.

190. EMERALD.—Beryl, Emerald; Phillips. Emeraude; Hauy. Dirhomboedrischer Smaragd; Mohs. Smaragd; Hausmann, Haidinger.

Rhombohedral. 100,111 = 44° 56′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *h* $3\bar{1}\bar{2}$, *r* 100, *r,* $\bar{1}22$, *p* 120, *n* $25\bar{1}$, *u* $13\bar{1}$, *x* $2\ 17\ \bar{1}\bar{3}$, *g* $41\bar{1}$, *g,* $5\ 11\ \bar{4}$, *v* 041, *v,* $23\bar{2}$, *w* 032, *w,* $28\bar{7}$.

bo	90°	0′	*uo*	49°	2′	*pp′*	28°	55′
bb″	60	0	*xo*	76	58	*nn′*	38	10
bh	10	54	*ao*	90	0	*uu′*	44	22
ba′	30	0	*wa*	14	30	*xx′*	58	18
ro	44	56	*va*	37	49	*zo*	44	56
po	29	57	*ar′*	52	17	*zr′*	41	22
no	40	50	*ga*	43	4	*rr′*	75	26

$aw_{,}$	14°	30′
$av_{,}$	37	49
$ag_{,}$	43	4

FIG. 352.

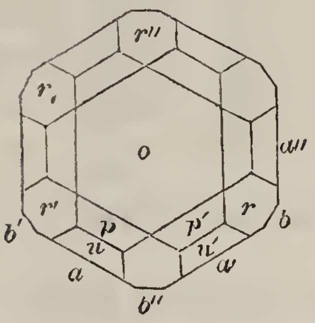
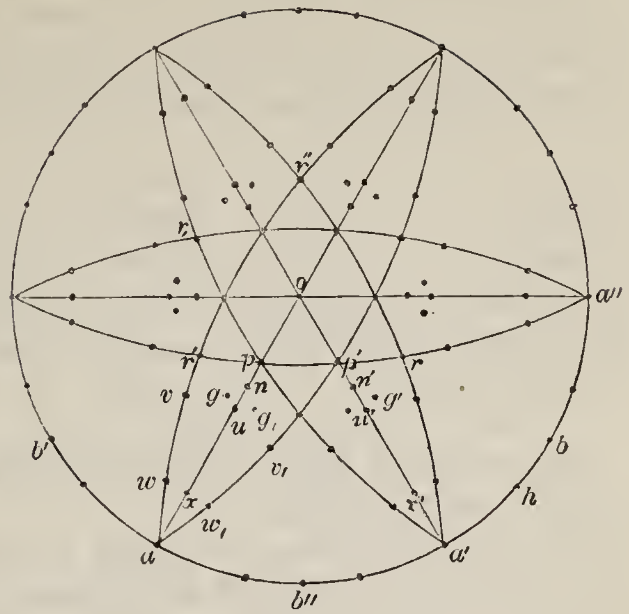


FIG. 353.



Combinations. *oa, oab, oap, oarr,, oaprr,u, oab..rr,.p, oaprr,uvv,, oapnrr,vv,xww,*. The faces *a*, *b* striated parallel to their intersections with each other. Cleavage. *o*, *a*; *a* usually interrupted. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous. R = 1·585. Double refraction very feeble. Green in the variety called emerald; colourless, blue, yellow, red, in the varieties called beryl. Streak white. H = 7·5 ...8·0. G = 2·67...2·75.

Before the blowpipe melts with difficulty on the edges into an opaque blebby glass. With borax melts into a transparent colourless glass. The chrome-green variety melts into a pale green globule. In salt of phosphorus dissolves slowly without leaving a skeleton of silica, and forms a globule which is opalescent when cold. With soda fuses into a clear and colourless bead. With fluor melts into a globule which is colourless while hot, and opaque and of a pale green colour when cold.

$\dddot{Al}\ddot{Si}^3 + 3\dot{G}\ddot{Si}$, silica 67·44, alumina 18·71, glucine 13·85.

Analyses of emerald *a* from Peru by Klaproth, *b* by Vauquelin, of beryl *c* from Siberia by Klaproth, *d* from Siberia by Du Menil, *e* from Siberia by Thomson, *f* from Fossum by Scheerer:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	68·50	64·40	66·45	67·00	66·86	67·00
Alumina	15·75	14·00	16·75	16·50	18·41	19·64
Glucine	12·50	13·00	15·50	14·50	12·54	12·56
Red oxide of iron . .	1·00	—	0·60	1·00	2·00	0·53
Lime	0·25	2·56	—	0·50	—	0·18
Oxide of chrome . .	0·30	3·50	—	—	—	—

Analyses of beryl *g* from Broddbo by Berzelius, *h* from Broddbo by C. Gmelin, *i* from Somero in Finland, *k* from Tamela in Finland, both by Moberg, *l* from Limoges by C. Gmelin, *m* from America by Schlieper:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	68·35	69·70	67·36	66·62	67·54	69·51
Alumina	17·60	16·83	16·46	16·51	17·63	14·49
Glucine	13·13	13·39	12·75	12·75	13·51	15·41
Red oxide of iron . .	0·72	0·24	1·50	3·03	Ċa, Ṁg	1·64
Tantalic acid . . .	0·72	—	0·28	0·10	—	—

In attached and imbedded crystals, in broken crystals and pebbles in alluvium.

The emerald-green varieties (emerald) are found at Muzo to the north of Santa Fé di Bogota in Peru, in Upper Egypt on the mountain Zabareh, on the river Takowaja near Bissersk in Siberia, in mica slate in Heubachthal in Salzburg, at Kjerringoë in Norway. The other varieties (beryl) are found at Ehrenfriedersdorf in Saxony and Schlackenwald in Bohemia in tin veins, Rabenstein and Zwiesel in Bavaria, the Rathhausberg in Salzburg, in Elba, Limoges in France, Gallicia, Sätersberg near Fossum, and Berbie near Fredrikshald in Norway; Lalaret and Broddbo near Fahlun in Sweden, Tammela in Finland, at Adun-Tschilon and Mursinsk in Siberia, the Tigeretz mountains in the Altai, in North America at Royalston and Goshen in Massachusetts, Bowtenham in Maine, Haddam and Monroe in Connecticut, Acworth in New Hampshire, Chester in Pennsylvania, Greenville and Abbeville in South Carolina, near Americana on the Rio St. Mattheo in the Brazils; in the Morne mountains in Ireland, and in Aberdeenshire.

191. PHENAKITE.—Phenakite; Dufrénoy. Rhomboedrisches Smaragd; Mohs. Phenakit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 37° 19′.

a $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *h* $3\bar{1}\bar{2}$, *r* 100, *z* $\bar{1}22$, *e* 011, *f* $\bar{1}11$, *p* 021, *t* 031, λ $03\bar{1}$, *s* $02\bar{1}$, *w* $21\bar{1}$, *y* $31\bar{1}$, *x* $12\bar{2}$. *r*, *p* are frequently hemihedral with inclined faces; *s*, *w*, *h* hemihedral with parallel faces.

hb	10°	54′	*zb*	127°	19′	*ta*	72°	52′
ba′	30	0	*fb*	146	44	*pa*	78	23
bb″	60	0	*sa*	28	23	*ea*	90	0
rb	52	41	λ*a*	39	2	*xa*	25	28
eb	110	52	*ar′*	58	20	*af″*	43	36

wa	62°	18′
ya	70	43
ra	90	0
rr′	63	20
ap″	66	15
pp″	23	14
ee′	35	56

FIG. 354.

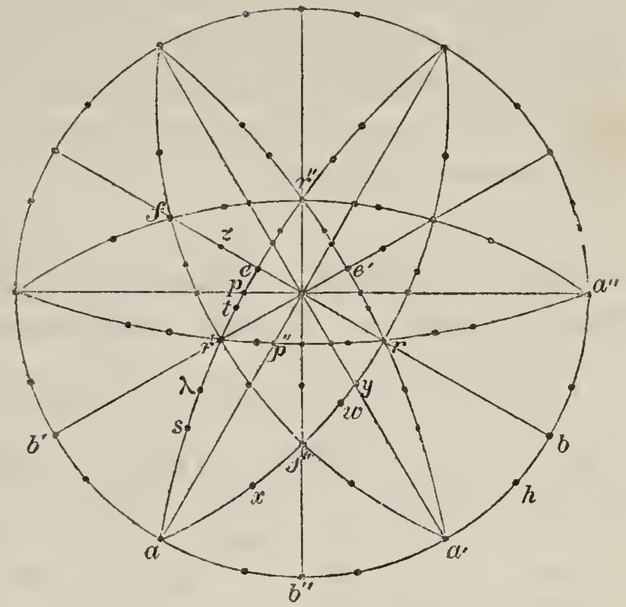


FIG. 355.

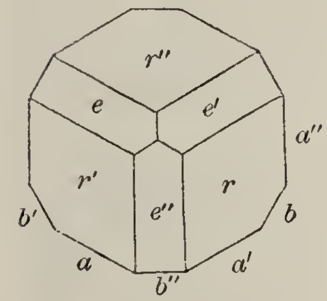


FIG. 356.

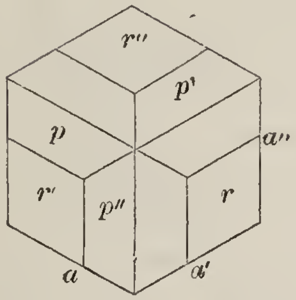
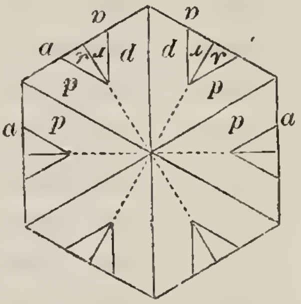


FIG. 357.



Combinations. *ra, pa, rpb, erab, apr′, rpa..s′.w′, rzepas′w`.b.* Twins. Twin-face *b.* Cleavage. *r, a,* not very distinct. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous. Colourless, yellow, brown. H = 7·5...8·0. G = 2·96...3·0.

Infusible before the blowpipe. With borax melts slowly into a clear glass. Dissolves slowly in salt of phosphorus leaving a skeleton of silica. With a little soda melts into a white bead, with more soda intumesces and becomes infusible. With solution of cobalt takes a blueish-grey colour. Insoluble in acids.

$\dot{G}^2\ddot{Si}$, silica 54·90, glucine 45·10.

Analyses of phenakite *a* from the Ural by Hartwall, *b* from Framont by Bischof:—

	a	*b*
Silica	55·14	54·40
Glucine	44·47	45·57
Lime and magnesia	—	0·10

In crystals; massive.

Is found with quartz in brown iron ore in the Upper Breuschthal near Framont in Alsace, with emerald and chrysoberyl in mica slate at Takowaja 85 wersts east of Katharinenburg, with green felspar and topaz, in granite veins in the Ilmen mountains in Siberia.

192. ZIRCON.—Zircon; Phillips, Hauy. Pyramidaler Zirkon; Mohs. Zircon; Hausmann, Haidinger.

Pyramidal. 101,001 = 32° 38′.

a 100, *e* 101, *m* 110, *p* 111, *v* 221, *u* 331, *x* 311, *y* 411, *z* 511.

ea	57°	22′	*yy′*	57°	6′	*uu′*	83°	9′
ee″	65	16	*yy″*	26	13	*vv′*	76	29
ee′	44	50	*xx′*	47	17	*xv*	23	39
ma	45	0	*xx″*	32	57	*zu*	32	2
aa′	90	0						
um	20	12						
vm	28	54						
pm	47	50						
pp″	84	20						
pp′	56	41						
za	20	21						
ya	24	52						
xa	31	43						
pa	61	40						
ae′	90	0						
zz′	64	4						
zz″	21	37						

FIG. 358.

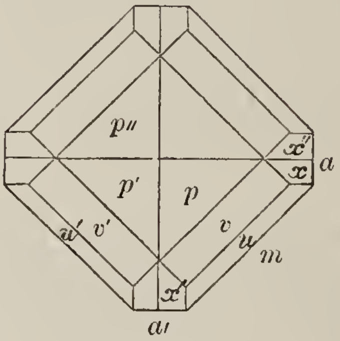
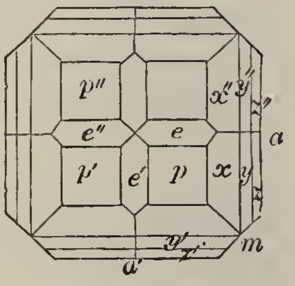


FIG. 359.



Forms and combinations. *p*, *pm*, *pa*, *pxma*, *pvma*, *pxum*, *pxuma*, *pvxuma*, *epxyma*, *epxyzma*. The faces *e* rough, *a* frequently rough and uneven. Cleavage. *p*, *m*, *m* more distinct than *p*, yet neither very perfect. Fracture conchoidal...uneven. Transparent...translucent on the edges. Lustre vitreous, inclining more or less to adamantine. $\mu = 1{\cdot}961$, $\mu' = 2{\cdot}015$. Red, brown, yellow, grey, green, white. Streak white. H = 7·5. G = 4·0...4·7.

Phosphoresces and loses its colour when heated. Its specific gravity is at the same time slightly increased. Infusible before the blowpipe. Soluble with difficulty in borax. Insoluble in salt of phosphorus. Partially decomposed by digestion in sulphuric acid.

$\dot{Z}r\ddot{S}$, silica 33·12, zirconia 66·88.

Analyses of zircon *a* from Friedrichswärn, *b* from the northern Circars by Klaproth, *c* from Ceylon by Vauquelin, *d* from Expailly by Berzelius, *e* from North Carolina by Vanuxem, *f* zircon, G = 4·615, by Henneberg, *g* from Litchfield in Maine, G = 4·7, by Gibbs:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Silica	33	32·5	32·6	33·48	32·08	33·85	35·39
Zirconia	65	64·5	64·5	67·16	67·07	64·81	63·56
Red ox. of iron . .	1	1·5	2·0	—	—	1·55	0·79
Lime	—	—	—	—	—	0·88	—

In attached and imbedded crystals, especially in gneiss, granite and basaltic rocks, in matter ejected by volcanoes, in alluvium and in the sand of rivers, with other gems and with gold.

Is found abundantly in syenite along the Christianiafjord from Stavärn to Hackedalen in Norway, in the miascite of the Ilmen mountains, especially in the neighbourhood of lake Ilmen near Miask in Siberia, in granite or gneiss in New Jersey, New York, Sweden, Scalpay in the island of Harris, Kitiksut in Greenland, Meissen, in boulders of syenite at Assuan in Upper Egypt, on the Saualp in Carinthia in a bed of quartz, calcite and epidote in gneiss, in basalt at Unkel and the Siebengebirge on the Rhine, in basaltic conglomerate at Habichtswald near Cassel; in amygdaloid at Expailly near Puy in France, and at Vicenza in Italy, near the lake of Laach, and in pale blue crystals, which were first sent to this country as zeagonite, at the foot of Vesuvius in ejected volcanic rocks. In isolated crystals in alluvium in Ceylon and many other places in the East Indies, Expailly in France, at Zöblitz, Podsedlitz and the Iserwiese in Bohemia, at Hohenstein and Sebnitz in Saxony, with gold in sand at Ohlapian and Muska in Transylvania, in the Ural and in Columbia.

According to Svanberg the earth in zircon is composed of zirconia and noria in different proportions. Hence the variations of specific gravity and hardness in crystals of zircon from different localities. Zircon from Stockholm, for example, is not so hard as zircon from other places, and its specific gravity is only 4·03. Noria is supposed to occur principally, though not exclusively, in zircon from Norway.

193. TOURMALINE.—Tourmaline; Phillips, Hauy. Rhomboedrischer Turmalin; Mohs. Turmalin; Hausmann, Haidinger.

Rhombohedral. 100,111 = 27° 20′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *h* $3\bar{1}\bar{2}$, *l* $4\bar{1}\bar{3}$, *e* 011, *r* 100, *s* $\bar{1}11$, *y* $3\bar{1}\bar{1}$, *w* $\bar{4}33$, *z* $\bar{3}22$, *q* $03\bar{1}$, *t* $02\bar{1}$, *u* $03\bar{2}$, *x* $21\bar{1}$, *v* $12\bar{2}$. The forms *o, e, s, y, w, t, u, q, b, h, l* are usually hemihedral with inclined faces. *s, y, w, t, u, q* occur on one end of the crystal, and *o, e* on the opposite end.

bo	90°	0′
aa′	60	0
bb″	60	0
ba′	30	0
ha′	19	6
la′	13	54
hb	10	54
lb	16	6
eo	14	29
ro	27	20
so	45	57
yo	64	11
wo	61	4
zo	68	51
ee′	25	1
rr′	46	52
ss′	77	0
yy′	120	0
ww′	98	34
zz′	107	44
er′	23	26
sr′	38	30
ua	24	46
ta	37	34
qa	49	5
ar′	66	34
va	32	9
as″	51	30
xa	68	19

FIG. 360.

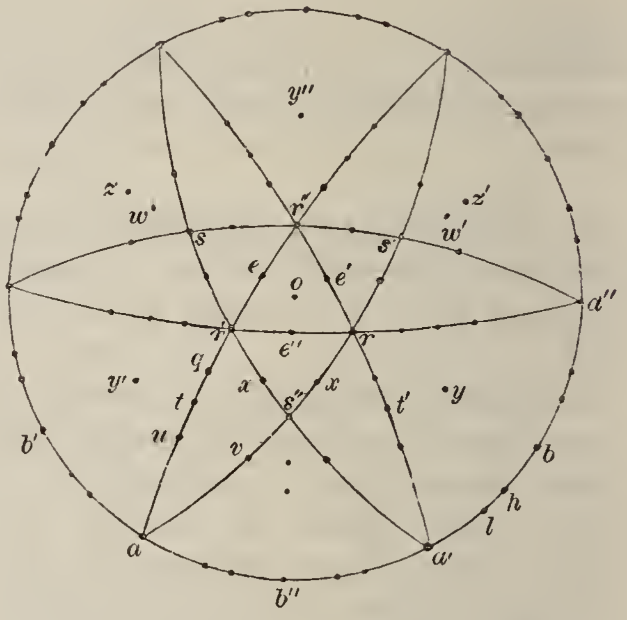


FIG. 361.

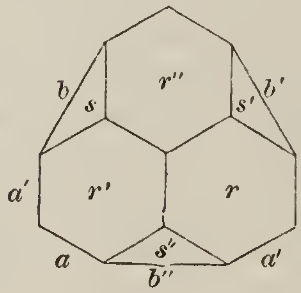


FIG. 362.

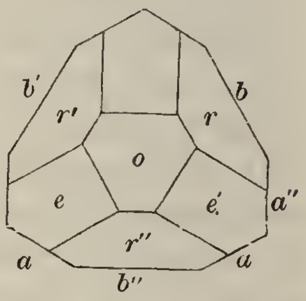


FIG. 363.

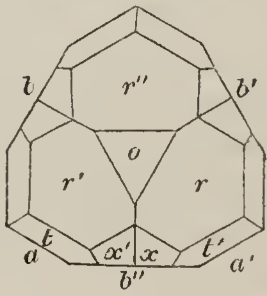
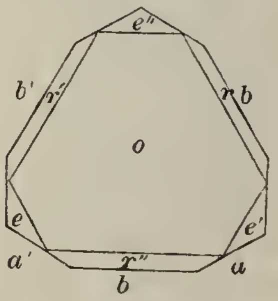


FIG. 364.



Combinations. Black tourmaline. *b‵r, ab‵r, b‵rs′, ab‵rs′, ab‵re‵s′, ab‵rs′u′, ab‵rs′y′, ab‵rs′h′, ab‵b′re‵, o‵ab‵b′re‵, ab‵b′h‵rse‵.* Brown tourmaline. *o‵ab‵b′h‵l′rex′tsyz′u′v′q′.* Green tourmaline. *o‵ar′s′, o‵ab‵re‵s′, oab‵re‵t′x′.* Red tourmaline. *ab′re‵, oab‵r′e, oab‵r′e‵, o‵ab‵r′t′, o‵ab‵r′e‵.* The face *o′* bright, *o‵* dull. In figs. 363, 364, which represent the opposite ends of the same crystals, o is bright in 363 and dull in 364. When all the faces of r occur, those of r' are striated parallel to their intersections with those of s, the faces of $r^{`}$ are smooth. $b$, $a$, $h$, $l$ are striated parallel to their intersections with each other. When all the faces of $b$ occur, those of $b^{`}$ are usually larger than those of b'. Cleavage. r, s imperfect. Fracture imperfect conchoidal...uneven. Transparent...almost opaque. Less transparent in the direction of the axis than perpendicular to it. Lustre vitreous. For light corresponding to Fraunhofer's line D, $\mu = 1{\cdot}6366$, $\mu' = 1{\cdot}6193$. In the coloured varieties of tourmaline the ordinary ray is almost entirely absorbed. Colourless, grey, yellow, green, blue, red, brown, black. The same individual sometimes exhibits different colours. The colour seen by transmitted light in the direction of the axis, is sometimes different from the colour seen in a direction perpendicular to the axis. Thus some crystals are yellowish-brown in the direction of the axis, asparagus-green in a direction perpendicular to the axis, or purple in the direction of the axis, blue in a direction perpendicular to the axis. Several of the tourmalines examined by Rammelsberg were found to exhibit pleochroism. Column O shows the colour by transmitted light polarized in a plane parallel to the axis of the rhombohedron, column E the colour by transmitted light polarized in a plane perpendicular to the axis:—

	O	E
Yell.-br., Windischkappel	Br.-yellow.	Yellow.
Brown, Orford . . .	Dark br.-yellow.	Light br.-yellow.
Black, Greenland . . .	Deep gr.-blue.	Reddish-brown.
Black, Snarum . . .	Green.	Reddish-brown.
Black, Unity	Blue.	Reddish-brown.
Black, Alabaschka . .	Bright blue.	Reddish-brown.
Black, Saar	Bright blue.	Reddish-brown.
Black, Langenbielau . .	Dark blue.	Reddish-brown.
Blu.-black, Sarapulsk .	Deep blue.	Pale blue.
Green, Elba	Pale green.	Very pale green.
Green, Brazils . . .	Yellowish-brown.	Oil-green.
Green, Chesterfield . .	Dark bl.-green.	Light bl.-green.
Red, Elba	Pale red.	Very pale red.

Streak white. $H = 7{\cdot}0\ldots7{\cdot}5$. $G = 3{\cdot}0\ldots3{\cdot}3$. Pyroelectric. While cooling, the extremity of the crystal, on which the faces of the hemihedral form s' occur, acquires vitreous electricity; and the extremity on which the faces of the hemihedral form $e^{`}$ occur, acquires resinous electricity. The end on which the half form s' appears, is the antilogous pole; and the end on which the half form *e*' appears, the analogous pole. Generally, but not invariably, the former is the end at which the edges formed by the faces *r* are directed towards the faces of the hemihedral form *b*', as in fig. 361; the latter that at which the edges formed by the intersections of the faces of *r* are directed to the intersections of the faces, as in fig. 362; figs. 361, 362, representing the opposite ends of the same crystal.

Before the blowpipe black tourmaline from Käringbricka melts with intumescence, and with borax and salt of phosphorus yields the reactions of iron and silica; tourmaline from Bovey melts into a black slag. The red and light green tourmalines containing lithia and soda intumesce, but do not melt. With soda they yield the reaction of manganese. With fluor spar and bisulphate of potash they all impart a green colour to the flame. After fusion, but not before, is almost completely decomposed by concentrated sulphuric acid.

Analyses by Rammelsberg of yellow and brown tourmaline containing but little iron and the largest quantity of magnesia, and in which the proportions of oxygen in the bases $\dot{R}$, $\dddot{\overline{R}}$ and the acids, are nearly as the numbers 1, 3, 5. *a* from Gouverneur in New York, *b* from Windisch-Kappel in Carinthia, *c* from Eibenstock in Saxony, *d* from Orford in New Hampshire, *e* from Monroe in Connecticut, *f* from the Zillerthal in the Tyrol:—

	a	*b*	*c*	*d*	*e*	*f*
G	3·049	3·035	3·034	3·068	3·068	3·054
Fluorine	2·28	2·10	2·51	2·50	2·38	2·50
Phosphoric acid . .	trace	0·12	—	0·24	—	0·24
Silica	38·85	38·08	37·83	38·33	39·01	37·94
Boracic acid . . .	8·25	9·39	8·88	9·86	9·04	8·58
Alumina	31·32	34·21	30·86	33·15	31·18	33·64
Red oxide of iron . .	1·27	1·43	4·85	3·07	3·44	2·79
Protoxide of iron . .	—	—	—	0·12	0·98	0·37
Magnesia	14·89	11·22	11·62	10·89	9·90	10·46
Lime	1·60	0·61	0·88	0·77	1·81	0·98
Soda	1·28	2·37	2·27	1·52	1·82	2·13
Potash	0·26	0·47	0·30		0·44	0·37

In analysis *b* the $\dddot{\overline{Fe}}$ contains $\dddot{\overline{Mn}}$.

Analyses of black tourmaline containing a mean proportion of iron and magnesia, and in which the proportions of oxygen in the bases $\dot{R}$, $\dddot{\overline{R}}$ and in the acids are nearly as the numbers 1, 4, 6. *g* from Gothaab in Greenland, *h* from Texas in Lancaster County, Pennsylvania, *i* from St. Gotthardt, *k* from

Havredal near Krageroe in Norway, *l* from Ramfossen near Snarum in Norway, *m* from Haddam in Connecticut, *n* from Haddam, having the appearance of being slightly decomposed, *o* from Unity in New Hampshire :—

	g	*h*	*i*	*k*
G	3·072	3·043	3·055	3·107
Fluorine	2·23	2·36	2·33	2·10
Phosphoric acid	0·11	0·20	0·24	0·08
Silica	37·70	38·45	38·00	37·11
Boracic acid	7·36	8·48	8·99	8·78
Alumina	34·53	34·56	32·28	31·26
Red oxide of iron	4·63	3·31	6·36	7·57
Protoxide of iron	0·25	($\dddot{\bar{\text{Mn}}}$ 0·09)	1·51	0·77
Magnesia	9·51	9·11	7·27	9·43
Lime	1·25	0·71	1·31	0·80
Soda	2·00	2·00	1·43	1·78
Potash	0·43	0·73	0·28	0·32

	l	*m*	*n*	*o*
G	3·145	3·136	3·132	3·192
Fluorine	1·71	1·78	1·95	1·59
Phosphoric acid	0·11	traces	—	—
Silica	37·22	37·50	36·55	36·29
Boracic acid	8·70	7·94	4·87	6·94
Alumina	29·70	30·87	32·46	30·44
Red oxide of iron	11·45	8·31	11·08	13·08
Protoxide of iron	0·86	1·06	0·50	2·38
Magnesia	7·94	8·60	8·51	6·32
Lime	0·65	1·61	1·80	1·02
Soda	1·13	1·60	2·28	1·94
Potash	0·53	0·73		

Analyses of the blackest tourmaline, with the largest proportion of iron and the smallest of magnesia, in which the proportions of oxygen in the bases $\dot{\text{R}}$, $\dddot{\bar{\text{R}}}$ and in the acids are nearly as the numbers 1, 6, 8, *p* from Bovey Tracy in Devonshire, *q* from Alabaschka near Mursinsk in the Ural, *r* from Sonnenberg near Andreasberg in the Harz, *s* from Saar in Moravia, *t* from Langenbielau in Silesia, *u* from Krummau in Bohemia :—

	p	*q*	*r*	*s*	*t*	*u*
G	3·205	3·228	3·243	3·181	3·152	3·135
Fluorine	1·49	1·54	1·64	1·30	1·43	1·90

	p	*q*	*r*	*s*	*t*	*u*
Phosphoric acid . .	0·12	—	0·12	trace	trace	—
Silica	37·00	35·74	36·51	36·82	37·24	38·43
Boracic acid . . .	7·66	8·00	7·62	8·70	7·62	8·06
Alumina	33·09	34·40	32·92	35·50	33·97	34·25
Red oxide of iron . .	9·33	7·61	8·13	6·57	10·77	9·98
Protoxide of iron . .	6·19	8·60	9·51	7·68	1·95	1·44
Protox. of manganese	—	—	0·11	—	—	—
Magnesia	2·58	1·76	0·78	1·55	3·65	3·84
Lime	0·50	0·86	0·72	0·81	0·62	0·44
Soda	1·39	1·02	1·36	0·98	1·93	1·36
Potash	0·65	0·47	0·58	0·09	0·82	0·30

In analysis *t* the red oxide of iron contains some oxide of manganese.

Analyses of dark violet, blue, green tourmaline generally containing lithia and iron along with manganese, and in which the proportions of oxygen in the bases $\dot{\text{R}}$, $\ddot{\bar{\text{R}}}$ and in the acids are nearly as the numbers 1, 9, 12, *v* blue, from Sarapulsk near Mursinsk, *w* violet, from Elba, *x* green, from Elba, *y* green, from Paris in the state of Maine, *z* green, from the Brazils, *a* green, from Chesterfield in Massachusetts:—

	v	*w*	*x*	*y*	*z*	*a*
G	3·162	2·942	3·112	3·069	3·107	3·108
Fluorine	1·75	2·00	2·35	2·00	2·09	2·10
Phosphoric acid . .	0·06	—	—	—	traces	—
Silica	38·30	36·71	38·19	38·47	38·55	40·26
Boracic acid . . .	6·32	7·11	7·58	7·69	7·29	7·79
Alumina	36·17	36·00	39·16	40·93	38·40	38·00
Red oxide of iron .	6·35	7·14	3·14	3·08	5·13	2·61
Oxide of manganese	3·71 ($\dot{\text{M}}$n	5·52	4·26	1·55	0·73)	0·90
Protoxide of iron .	3·84	—	—	—	2·00	3·80
Magnesia	0·53	2·30	1·00	1·21	0·73	0·80
Lime	0·27	0·80	0·84	0·88	1·14	0·81
Soda	2·37	2·04	2·40	2·36	2·37	2·09
Lithia	—	—	0·74	1·47	1·20	0·20
Potash	0·33	0·38	0·34	0·36	0·37	0·64

Analyses of red tourmaline containing lithia but no iron, in which the proportions of the oxygen in the bases $\dot{\text{R}}$, $\bar{\bar{\text{R}}}$ and in the acids are nearly as the numbers 1, 12, 15, *β* from Elba, *γ* from Paris in Maine, *δ* from Schaitansk in the Ural, *ε* from Rozena in Moravia, probably decomposed:—

	β	γ	δ	ε
G	3·022	3·019	3·082	2·998
Fluorine	2·41	2·58	2·47	2·70
Phosphoric acid	0·10	0·27	0·27	0·22
Silica	39·27	38·33	38·38	41·16
Boracic acid	7·87	9·00	7·41	8·56
Alumina	44·41	43·15	43·97	41·83
Oxide of manganese	0·64	1·12	2·60	0·97
Magnesia	0·78	1·02	1·62	0·61
Lime	—	—	0·62	—
Soda	2·00	2·60	1·97	1·37
Lithia	1·22	1·17	0·48	0·41
Potash	1·30	0·68	0·21	2·17

Occurs in attached and imbedded crystals, in gneiss, granite, mica slate, and in the veins which traverse those rocks, in pebbles in stream tin works, and in the sand of rivers.

Colourless transparent varieties are found in the dolomite of Campo Longo on the Grimsel; the red in lepidolite and quartz at Rozena in Moravia, Penig in Saxony, Massachusetts, Schaitansk and Sarapulsk not far from Mursinsk, and at Miask in Siberia; the blue at Utö in the gulf of Bothnia, Massachusetts and Goshen in North America; yellow and brown tourmaline on St. Gotthardt, Windishkappel in Carinthia, Ceylon, Pegu, Madagascar; the green at Penig, Rozena, Campo Longo, Piedmont, Katharinenburg, Massachusetts, Villa Rica in the Brazils, Madagascar. Black tourmaline, or schörl as it is sometimes called, is found at Penig, Rochsburg, Eibenstock, and Neustadt in Saxony in granite, Andreasberg, Hörlberg near Bodenmais in Bavaria, Karlsbad, Pfitsch, Faltigl and Ratschinges in the Tyrol, Bovey in Devonshire, St. Just in Cornwall, Käringbricka in Sweden, Arendal and Langöe in Norway, Karosulik in Greenland, Polökowskoi on the mountain Auschkul, near the lake Scharlasch near Beresowsk, Alabaschka near Mursinsk, Gornoischit near Katharinenburg, Werchneiwinsk near Newjansk, in the topaz veins of the Ilmen mountains, in the quartz of Totschilnaja Gora, in granite at Schaitansk and at Bohorodskoi on the Tura, Vicdessos, Luchon and Sallat in the Pyrenees, Madagascar, in granite at Portsoy in Banffshire. Transparent crystals of various colours are found in Elba; they frequently exhibit parallel zones of different colours, being red at the two extremities and blue in the middle, blackish-green at the end by which they are attached and red at the other extremity, or partly grass-green and partly azure-blue.

The angle *so* deduced from Kupffer's measure is 45° 54′ in black tourmaline, 45° 57′ in green tourmaline, and 46° 2′ in red tourmaline. In white tourmaline, from a mean of Mr. Brooke's measures, *so* = 45° 53′. A crystal of green tourmaline (in which the close agreement of the angles between every two of the three faces *s*, *s′*, *s″*, showed that it was a single crystal, and not an aggregation, such as is frequently observed, of two or more crystals in positions nearly, but not quite parallel) gave *so* = 45° 57′·6. A crystal not quite so good gave the same result. The angles in other crystals were found as follows: red tourmaline, *so* = 46° 12′. In black tourmaline, said to be from Modum, *so* = 46° 12′·8. In light brown tourmaline, *so* = 46° 4′. The angles of the supposed crystal of tourmaline described by Marignac (Bib. Univ. Gen. 1847. T. 6. p. 299) agree with those of the combination *abrepw* of phenakite.

194. AXINITE.—Axinite; Phillips, Hauy. Prismatischer Axinit; Mohs. Axinit; Hausmann, Haidinger.

Anorthic. 011,010=45° 12′; 001,011=44° 43; 101,001=56° 55′; 100,101=40° 51′; 100,010=77° 30′.

v 100, *p* 010, *m* 001, *r* 011, *z* 012, *e* $01\bar{1}$, *y* 101, *l* 120, *u* 110, *w* $1\bar{1}0$, *x* 111, *s* 121, *i* 131, *c* $1\bar{1}1$, *q* $2\bar{1}1$, *n* $1\bar{1}\bar{1}$, *o* $1\bar{1}2$.

lp	28°	57′	*yp*	79°	24′	*sr*	36°	22′
up	44	35	*xr*	40	48	*us*	27	59
vp	77	30	*vr*	86	46	*ue*	55	14
wp	119	50	*xm*	64	57	*yu*	49	44
rp	45	12	*ux*	30	34	*wy*	56	58
zp	63	34						
mp	89	55						
ep	45	17						
em′	44	48						
yv	40	51						
my	56	55						
ip	24	33						
sp	33	21						
xp	49	32						

FIG. 365.

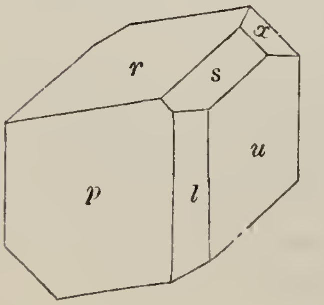
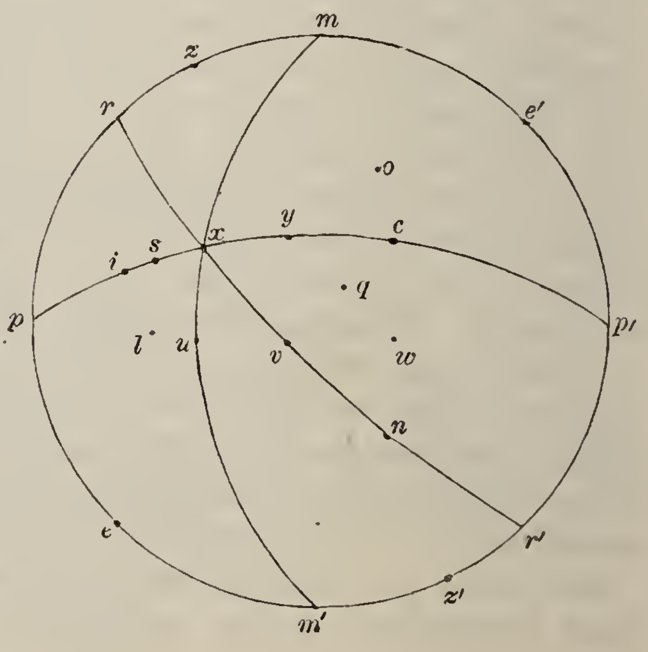


FIG. 366.



Combinations. upr, $uprsl$, $uprslx..z.y.o.n.e.m.v.w.i.$ The faces v rough; r, z striated parallel to their intersections with each other; u, l, and sometimes also v, p, striated parallel to their intersections with each other. Cleavage. v, y; p, m, traces; r, indistinct and interrupted. Fracture conchoidal...uneven. Transparent...translucent on the edges. Lustre vitreous. R = 1·735. Close brown of various shades, inclining to plumb-blue and pearl-grey. Exhibits trichroism. On looking through a crystal in the direction of either optic axis, a dark violet stripe is seen, interrupted at the point occupied by the axis. Brittle. H = 6·5...7·0. G = 3·29...3·30. Acquires vitreous electricity by friction. Pyroelectric. The angles uxp, $u'x'p$ are analogous poles, and the angles rxp', $r'x'p$ antilogous poles.

Before the blowpipe intumesces, and melts easily into a dark green glass, which becomes black in the outer flame. With borax and salt of phosphorus yields a glass coloured by iron, and in the outer flame becomes violet. In salt of phosphorus a skeleton of silica is left. With soda yields the reaction of manganese. With fluor spar and bisulphate of potash imparts a green colour to the flame. After fusion is completely decomposed by hydrochloric acid, leaving a jelly of silica.

Analyses of axinite *a*, *b*, *c* from Oisans, *d* from Treseburg, *e* from Berkutzkaja Gora near Miask, *f* from Oisans, in order to determine the red oxide of iron and boracic acid, all by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	43·47	43·68	not det.	43·74	43·72	—
Alumina . .	16·30	15·63	17·17	15·66	16·92	—
Red ox. iron .	10·25	9·45	9·31	11·94	10·21	8·26
Ox. mang. .	2·74	3·05	2·94	1·37	1·16	—
Lime	19·90	20·67	20·00	18·90	19·97	—
Magnesia . .	1·55	1·70	1·94	1·77	2·21	—
Potash . . .	not det.	0·64	0·11	6·62	5·81	—
Boracic acid .		5·61	not det.			3·40

It appears from the nature of the analytical processes employed that the amount of boracic acid is less than 5·61 and greater than 3·40.

In attached crystals and massive, usually in veins or beds in granite, diorite, diabase, gneiss, mica slate, clay slate.

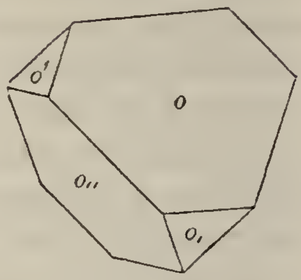
Is found at Bourg d'Oisans in Dauphiné, Botallack in Cornwall, Barèges, Pic d'Ereslids and other places in the Pyrenees, Mont Anvert in Savoy, St. Gotthardt, Santa Maura in the Grisons, Monzoni in the Tyrol, in Saxony at Thum, Schneeberg, Schwarzenberg and Grünstädtel, Arendal and Kongsberg in Norway, near Philipstadt in Sweden, Berkutzkaja Gora near Miask in the Ural, Andreasberg and Treseburg in the Harz.

195. HELVIN.—Helvin; Phillips, Hauy, Hausmann, Haidinger. Tetraedrischer Granat; Mohs.

Cubic.

o 111.

FIG. 367.



oo'	70°	32'
oo,,	109	28

Four alternate faces of *o* are larger than the other four alternate faces. The larger faces smooth, rather curved and uneven, sometimes striated parallel to their edges; the smaller faces rough, but even. Fracture uneven. Translucent on the edges. Lustre vitreous, inclining to resinous. Brown, yellow, green of various shades. Streak white. Brittle. H = 6·0...6·5. G = 3·1...3·3.

Before the blowpipe in the inner flame melts with intumescence into a yellow opaque bead. With borax in the outer flame fuses into a transparent violet glass. With salt of phosphorus yields a skeleton of silica. With soda on platinum foil becomes green. Is decomposed by hydrochloric acid with evolution of sulphuretted hydrogen, and forms a jelly of silica.

$3\dot{R}^2\ddot{S} + MnSu$, where $\dot{R}$ is glucine and protoxides of iron and manganese.

Analyses by C. Gmelin:—

Silica	33·26	35·27
Glucine	12·03	9·47
Protoxide of iron . . .	5·56	7·99
Protoxide of manganese .	44·68	42·13
Sulphur	5·06	—

Is found in attached and imbedded crystals, in a bed in gneiss at Schwarzenberg in Saxony. It is said to occur also on the Kalte Kober near Breitenbrunn in Saxony, and at Hortekulle near Modum in Norway.

196. EULYTINE.—Bismuth blende; Phillips. Bismuth silicaté; Dufrénoy. Dodekaedrische Demant-Blende; Mohs. Kieselwismuth; Hausmann. Eulytin; Haidinger.

Cubic.

a 100, *d* 011 cleavage, *o* 111, *n* 211. The forms *o*, *n* are hemihedral with inclined faces.

aa'	90°	0'
oo'	70	32
oa	54	44
dd'	60	0
da'	45	0
nn'	33	33
$nn_{,}$	48	11
$n'n_{,,}$	70	32
na	35	16
no	19	28
nd	54	44

FIG. 368.

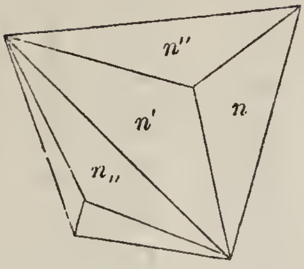
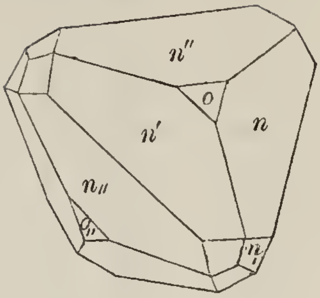


FIG. 369.



Forms and combinations. *n'*, *an'*, *n'n‵*, *o'n'n‵*. Twins. Twin face *d*. The faces *n* are striated parallel to their intersections with the faces *d*. The edges sometimes rounded. Semi-transparent... opaque. Lustre adamantine. Brown, inclining to yellow and black. Brittle. H = 4·5...5·0. G = 5·965.

Before the blowpipe on charcoal melts with effervescence into a brown bead, depositing a yellowish-brown sublimate on the charcoal. With soda yields bismuth. In salt of phosphorus leaves a skeleton of silica. Soluble in hydrochloric acid forming a jelly of silica.

Analysis by Kersten :—

Silica	22·23
Oxide of bismuth	69·38
Red oxide of iron	2·40
Oxide of manganese	0·30
Phosphoric acid	3·31
Water, hydrofluoric acid and loss .	2·38

In very small attached crystals, single or united in small druses and globular groups.

Is found in the cobalt veins of Schneeberg, and at Bräunsdorf near Freiberg in Saxony.

197. HUMITE.—Humite, Chondrodite; Phillips. Chondrodite; Hauy. Hemiprismatischer Chrysolith; Mohs. Chondrodit; Hausmann, Haidinger.

Oblique. 101,100 = 64° 0'; 111,010 = 37° 43'; 101,001 = 36° 48'.

a 100, *b* 010, *c* 001, *d* 021, *n* 011, *k* 023, *w* 401, *u* 201, *v* 403, *z* 101, *e* $\bar{4}03$, *r* $\bar{2}01$, *x* $\bar{4}01$, *m* 110, *f* 111, *p* 211, *s* $\bar{1}11$, *h* 112, *l* 221, *t* $\bar{2}21$, *i* $\bar{4}21$, *q* 623, *g* 423, *y* 223, *o* $\bar{2}23$.

wa	21°	38′	*fb*	37°	43′	*ix*	43°	8′
ua	40	37	*ff′*	75	26	*pa*	56	56
va	54	29	*qb*	58	1	*fa*	74	27
za	64	0	*pb*	46	53	*na*	96	13
ca	100	48	*lb*	28	6	*sa*	116	24
ea	137	36	*pu*	43	7	*qc*	65	3
ra	147	8	*gb*	52	2	*hc*	39	43
xa	161	0	*gv*	37	58	*yc*	48	33
kc	43	17	*yb*	48	21	*fc*	60	40
nc	54	43	*hb*	54	34	*lc*	76	27
dc	70	31	*ob*	51	7	*mc*	94	35
bc	90	0	*sb*	42	39	*ct′*	111	52
kk′	93	26	*ss′*	85	18	*cs′*	125	50
nn′	70	34	*tb*	32	38	*co′*	136	13
dd′	38	58	*tr*	57	22	*sbc*	30	12
ma	64	45	*ib*	46	52			
ba	90	0						
mm′	50	30						
fz	52	17						

FIG. 370.

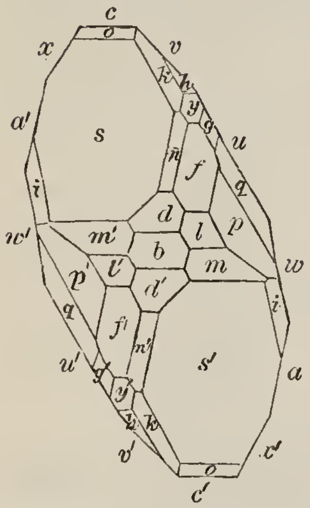
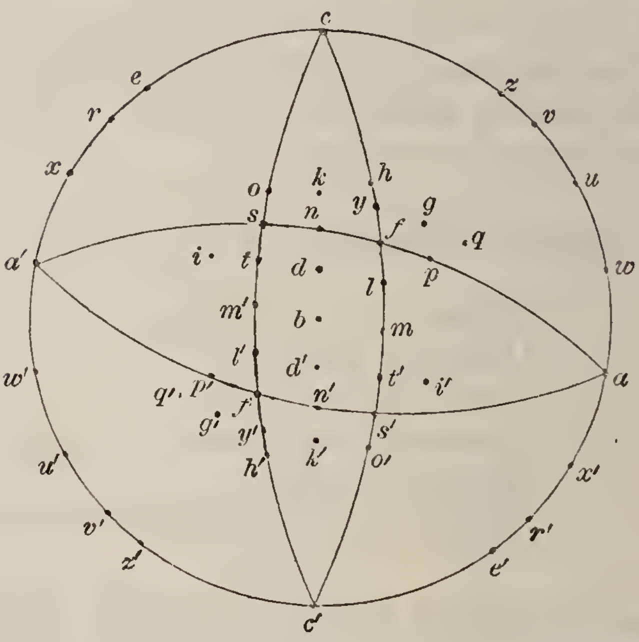


FIG. 371.



Twins. Twin-face *u*. Cleavage, *c*. Fracture uneven… conchoidal. Transparent…translucent. Lustre vitreous, inclining to resinous. Yellow of various shades…reddish-brown, grey. Streak white. H = 6·5. G = 3·10…3·20.

In the open tube with salt of phosphorus yields the reaction of fluorine. Infusible before the blowpipe. Dissolves in salt of phosphorus leaving a skeleton of silica. With borax fuses slowly but completely into a clear glass slightly tinged by iron. Soluble in hydrochloric acid leaving a jelly of silica. Soluble in sulphuric acid which expels the fluorine.

$3\dot{\mathrm{M}}\mathrm{g}^2\ddot{\mathrm{Si}} + \mathrm{MgFl}$, silica 37·28, magnesia 50·06, magnesium 5·11, fluorine 7·55. Part of the magnesia is replaced by protoxide of iron.

Analyses of the less distinctly crystallized variety (chondrodite) *a*, *b* from North America, *c*, *d* from Pargas, all by Rammelsberg, *e* from New Jersey by W. Fisher, *f* crystallized (humite) from Vesuvius by Marignac:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	33·06	33·97	33·10	33·19	33·35	30·88
Magnesia . .	55·46	56·97	56·61	54·50	53·05	56·72
Protox. iron .	3·65	3·48	2·35	6·75	$\overset{\cdots}{\mathrm{F}\!\!\!-\!\mathrm{e}}$ 5·50	2·19
Fluorine . .	7·60	7·44	8·69	9·69	7·60	not det.

G. Rose convinced himself of the presence of fluorine in humite.

Is found in crystals having rough surfaces and in round imbedded grains (chondrodite) in granular limestone at Pargas in Finland, Aker and Gullsjö in Sweden, imbedded in dolomite at Taberg near Philipstad in Sweden, in New Jersey, New York, and other places in the United States. It occurs also in very perfect crystals (humite) in the Fossa Grande on Vesuvius.

Humite has been described by preceding authors, with the exception of G. Rose, as belonging to the prismatic system, an error into which they have probably been led by the very near agreement of the angles *rc* and *vc*, *xc* and *uc*, *ca′* and *wc*, and by regarding the absence of the symmetry which belongs to crystals of the prismatic system, as imperfections only of the particular crystals examined. We have however found the faces given in our figure recurring so uniformly on several well-formed crystals as to leave no doubt of the form being oblique.

198. TOPAZ. — Topaz; Phillips, Hausmann, Haidinger. Topaze; Hauy. Prismatischer Topaz; Mohs.

Prismatic. 011,010=29° 5′·5; 101,001=43° 30′·5; 110,100=62° 9′·5.

a 100, *c* 001, *i* 011, *d* 013, *w* 401, *y* 201, *n* 101, *e* 203, *m* 110, *z* 320, *l* 210, *u* 310, *v* 410, *k* 111, *o* 112, *s* 113, *r* 211, *x* 213, *t* 315, *f* 114, *q* 413. Some of the forms are hemihedral with inclined faces, having only those faces which occur on one side of the zone *mm′*, and on some crystals which have only one end terminated by faces, the face *i* and several others occur on one side only of the zone *ca*.

dc	30°	55′	*yc*	62°	13′	*ua*	32°	16′
dd′	61	50	*wc*	75	15	*la*	43	26
ic	60	55	*ac*	90	0	*za*	51	37
ii′	121	49	*nn′*	87	1	*ma*	62	10
ec	32	19	*yy′*	124	26	*ll′*	93	8
nc	43	31	*va*	25	20	*mm′*	55	41

ki	24°	47′	*ff′*	24°	23′	*rc*	69°	5′
kk′	49	33	*ff″*	47	14	*ry*	39	54
kn	52	41	*sd*	15	11	*oo′*	38	53
kk″	105	21	*xd*	28	30	*oo″*	78	8
ri	42	43	*qd*	47	21	*qc*	54	27
rr′	85	26	*ss′*	30	22	*qq′*	94	42
fc	26	56	*ss″*	59	28	*qq″*	40	44
sc	34	7	*xx′*	56	59	*tc*	33	57
oc	45	28	*xx″*	53	42	*tt′*	56	22
kc	63	48	*xc*	41	4	*tt″*	34	42
mc	90	0	*xe*	26	51			

FIG. 372.

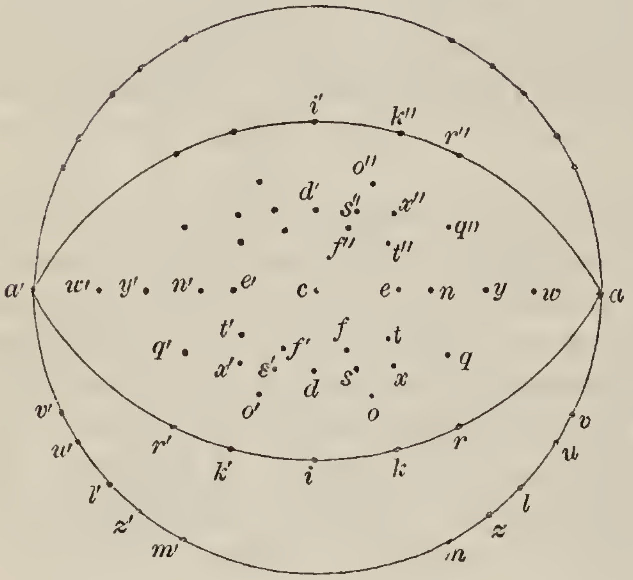


FIG. 373.

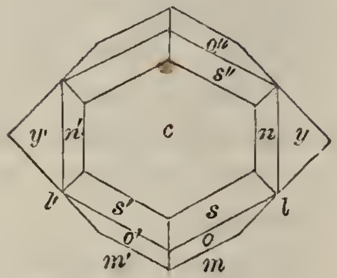
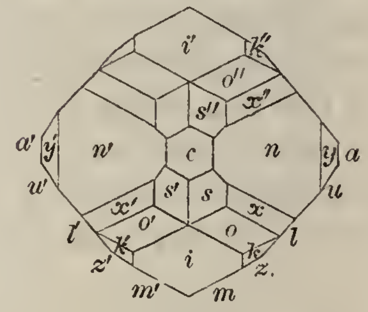


FIG. 374.



Combinations. *oml, yml..c.o.z.ua, onml, oniml, fsxonml, csonml..x.y, xonml, csoknymzlu.a.xi, acinymlukot, cidenymlkos. wvr, mlo′c′*. The faces *c* rough, sometimes striated parallel to their intersections with *l*; *m, z, l, u, v* sometimes striated parallel to their intersections with each other. Cleavage. *c*, very perfect; *i, n* imperfect; *m, l* traces, especially in the varieties from Scotland. Fracture conchoidal more or less perfect...uneven. Transparent...translucent on the edges. Lustre vitreous.

The indices of refraction of a white topaz for rays in planes parallel to *a*, perpendicular to *a, c*, parallel to *c*, and polarized in those planes respectively, have been determined by Rudberg. They are, for rays corresponding to Fraunhofer's lines,

H	1·62745	1·62539	1·63506
G	1·62365	1·62154	1·63123
F	1·61914	1·61701	1·62652
E	1·61668	1·61452	1·62408

D	1·61375	1·61161	1·62109
C	1·61144	1·60935	1·61880
B	1·61049	1·60840	1·61791

The optic axes lie in a plane parallel to *a*. In the variety examined by Rudberg they made angles of 28° 19′·5 with a normal to *c* within the crystal, and angles of 50° 2′, when seen in air through planes parallel to *c*. In Brazilian topaz they make angles of 24° 55′ with a normal to *c*. In topaz from Schneckenstein they make angles of 57° 6′ with a normal to *c*, when seen in air through planes parallel to *c*. This angle becomes larger when the crystal is heated. Colourless, yellowish-white...yellow, reddish-white...hyacinth-red, blue-green. Exhibits trichroism. A variety from the Brazils, by transmitted light polarized in a plane parallel to *a*, straw-yellow, by light polarized in a plane perpendicular to *a*, *c*, honey-yellow, and by light polarized in a plane parallel to *c*, wine-yellow. Streak white. H = 8·0. G = 3·4...3·6. Pyroelectric, the middle of *c* being analogous, and the edges *mm′* antilogous.

Heated strongly in the open tube with salt of phosphorus yields the reaction of fluorine. Infusible before the blowpipe; in a strong heat blisters form on the surface, but not on the faces of cleavage, and burst immediately. Soluble in salt of phosphorus leaving a skeleton of silica. With borax fuses slowly into a clear glass. With solution of cobalt becomes blue. Digested with sulphuric acid yields hydrofluoric acid. By ignition the dark yellow varieties become red, and the pale yellow varieties colourless, retaining their transparency.

$2AlF^3 + 3SiF^2 + 12\dddot{Al}\ddot{Si}$, fluorine 17·28, oxygen 36·65, silicon 16·94, aluminium 29·14. The silicon and aluminium correspond to silica 35·26, alumina 54·80.

Analyses of topaz *a* from Schneckenstein, *b* from the Brazils, *c* from Finbo, all by Berzelius, *d* from the Brazils, *e* from Trumbull in Connecticut, *f* from Finbo, all by Forchhammer :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	34·24	34·01	34·36	—	35·39	36·66
Alumina	57·45	58·38	57·74	54·88	55·96	55·16
Fluorine	14·99	15·06	15·02	17·33	17·35	17·79

The quantities of fluorine in *d*, *e*, *f*, deduced from the loss sustained by exposure to a very high temperature, which drives off the whole of the fluorine in combination with silicon, were 16·50, 16·86, 17·84 respectively.

Usually in attached crystals, seldom in imbedded crystals, massive or disseminated, in veins and druses, in granite, gneiss and porphyry.

Is found, green, blue and colourless at Alabaschka near

Mursinsk, Miask and Adun-Tschilon in Siberia, Kamtskatka, Peru, Rozena in Moravia with lepidolite, Mucla in Asia Minor, Penig in Saxony, at Schneckenstein near Auerbach in Saxony of a wine-yellow colour, at Villa Rica in the Brazils of a deep yellow colour; with tin ore at Geyer, Ehrenfriedersdorf and Altenberg in Saxony, and Schlackenwald in Bohemia, with tin ore and apatite in veins in granite at St. Michael's Mount and Huel Kind near St. Agnes in Cornwall, at Trumbull and Middleton in Connecticut, in granite in the Morne mountains in Ireland. In isolated crystals in alluvial soil at Eibenstock in Saxony, Fribus in Bohemia, Orio-Branco and the river Ita Inga in the Brazils, New South Wales, Cairn Goram in Aberdeenshire. The less transparent variety (pyrophysalite) with fluor in granite veins at Finbo near Fahlun, and in boulders at Broddbo near Fahlun in Sweden, in gneiss at Fossum near Modum in Norway.

Topaz from New South Wales, the Brazils and Scotland, sometimes contains cavities in which Sir David Brewster discovered two fluids, one of which has an index of refraction = 1·211, and expands 0·25 of its original volume on being heated from 10° to 27°.

According to Mohs and Hausmann, 'pycnite' is a variety of topaz having the faces *a*, *m*, and a perfect cleavage parallel to the face *c*, with planes of union sometimes parallel and sometimes making an angle with *c*. Fracture imperfect conchoidal ...uneven. Translucent...translucent on the edges. Lustre on the cleavage planes vitreous, on the surfaces of fracture feeble. Yellow, green, red, grey. Streak white. H = 7·5. G = 3·494...3·535. Pyroelectric. Infusible before the blowpipe, but blisters more readily than topaz. Analyses of pycnite from Altenberg, *a* by Berzelius, *b* by Forchhammer:—

	a	*b*
Silica	38·43	39·04
Alumina	51·00	51·25
Fluorine	17·10	18·48

Is found in parallel columnar aggregations, at Altenberg in Saxony, Schlackenwald in Bohemia, at Mauleon in France in steatite, at Kongsberg in Norway in mica slate.

199. LEUCOPHANE.—Leucophane; Dufrénoy. Leukophan; Hausmann, Haidinger.

Anorthic.

Fracture uneven. Transparent...translucent. Lustre vitreous on cleavage planes, inclining to resinous on the surfaces of fracture. Pale greenish-grey...light wine-yellow. Streak white.

Very tough. H = 3·75. G = 2·974. Phosphoresces with a blue light when struck with a hammer or heated. Becomes feebly electric by pressure and also when heated.

Before the blowpipe melts into a clear bead tinged with violet. In borax fuses readily into a clear amethyst-coloured glass.

$3\dot{C}a\ddot{S}i + \dot{G}^3\ddot{S}i^2 + NaF$, silica 48·6, lime 26·3, glucine 11·9, sodium 7·3, fluorine 5·9.

Analysis by Erdmann:—

Silica	47·82
Glucine	11·51
Lime	25·00
Protoxide of manganese .	1·01
Potassium	0·26
Sodium	7·59
Fluorine	6·17

Is found imbedded in syenite in the Lammön rock below Stokön at the mouth of the Langesund-fjord in Norway.

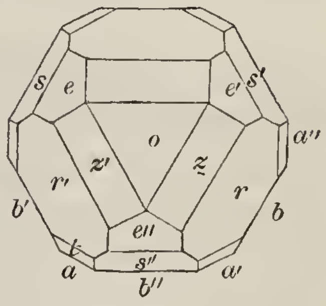
200. EUDIALYTE.—Eudyalite; Phillips, Hauy. Rhomboedrischer Almandin-Spath; Mohs. Eudialyt; Hausmann, Haidinger.

Rhombohedral. 100,111 = 67° 42′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *r* 100, *e* 011, *z* 211, *s* $\bar{1}11$, *t* $02\bar{1}$.

aa′	60°	0′	*rr′*	106°	30′
ba′	30	0	*ss′*	116	4
bb″	60	0	*ta*	13	59
zo	31	22	*tr*	22	46
ro	67	42	*ze′*	42	2
bo	90	0	*re′*	53	15
eo	50	38	*rs′*	58	2
so	78	25	*ra′*	36	45
to	81	11	*ae″*	47	58
zz′	53	35	*as″*	31	58
ee′	84	4			

FIG. 375.



Combinations. *ozra*, *ozrs*, *ozrba*, *ozerba*, *ozersba*, *ozerstba*. Cleavage. *o*, distinct; *z*, less distinct; *r*, *a* traces, seldom observable. Fracture conchoidal...uneven. Translucent on the edges...opaque. Lustre vitreous. Dark peach-blossom-red... brownish-red. Streak white. Slightly brittle. H = 5·0...5·5. G = 2·84...2·95.

In the matrass yields a little moisture. Before the blowpipe melts into a greyish-green opaque slag. With borax fuses readily into a clear glass slightly coloured by iron. With salt of phosphorus the silica intumesces so that the bead cannot take a globular form. In hydrochloric acid is partly decomposed and gelatinizes.

$2\dot{R}\ddot{S}i + \dot{Z}r\ddot{S}i$, where $\dot{R}$ denotes soda, lime, protoxides of iron and manganese.

Analyses *a* by Stromeyer, corrected by Rammelsberg, *b* by Rammelsberg :—

	a	*b*
Silica	52·48	49·92
Zirconia	10·89	16·88
Protoxide of iron	6·16	6·97
Protoxide of manganese . .	2·31	1·15
Lime	10·14	11·11
Soda	13·92	12·28
Potash		0·65
Chlorine	1·00	1·19
Loss by ignition	1·80	0·37

Rammelsberg supposes that in analysis *a* the silica contained some zirconica.

According to Svanberg, the zirconia obtained from eudialyte contains a new oxide, resembling, in some of its properties, the substance which went by the name of yttria previous to its separation into yttria and the oxides of erbium and terbium, but does not perfectly resemble either of them.

In attached crystals; massive, granular, disseminated.

Is found at Kangerdluarsuk in West Greenland with sodalite, arfvedsonite and felspar.

201. WÖHLERITE.—Wohlérite; Dufrénoy. Wöhlerit; Hausmann, Haidinger.

Traces of cleavage. Fracture conchoidal...splintery. Translucent more or less. Lustre vitreous, on surfaces of fracture resinous. Yellow, brown, grey. Streak yellowish-white. H = 5·5. G = 3·41.

Before the blowpipe in a strong heat melts quietly into a yellowish glass. Imparts the colours of iron and manganese to borax and salt of phosphorus. Is decomposed by warm concentrated hydrochloric acid, leaving a residue of silica and pelopic acid.

Analysis by Scheerer :—

Silica	30·62
Pelopic acid	14·47
Zirconia	15·17

Protoxide of manganese	1·55
Magnesia	0·40
Lime	26·19
Soda	7·78
Water	0·24

Is found in tabular and columnar crystals, and angular grains, in some islands in Langesund-Fjord, and in the island of Rödkindholmen near Friedrichswärn in Norway.

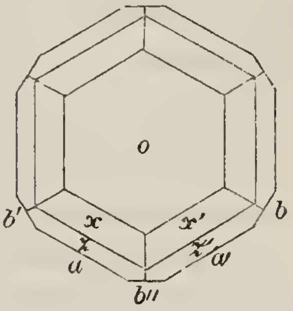
202. NEPHELINE.—Nepheline; Phillips, Hauy. Rhomboedrischer Elain-Spath; Mohs. Nephelin; Hausmann, Haidinger.

Rhombohedral. 100,111 = 59° 10′.

o 111, a $01\bar{1}$, b $2\bar{1}\bar{1}$, x 120, z $13\bar{1}$.

ao	90°	0′
aa'	60	0
ba'	30	0
xo	44	3
zo	62	40
xx'	40	41
zz'	52	44

FIG. 376.



Combinations. *oa, oax, oaxz, oabxz.* Cleavage. *o, a* imperfect. Fracture conchoidal...uneven. Transparent...feebly translucent. Lustre vitreous. Surfaces of fracture, especially of the coloured varieties, resinous. Colourless, greenish-grey, flesh-red inclining to brown, blue inclining to green. Streak white. Brittle. H = 5·5...6·0. G = 2·58...2·64.

Before the blowpipe nepheline melts with difficulty, elæolite more readily, into a blebby glass. Is decomposed with great difficulty by salt of phosphorus. With solution of cobalt the melted edges become blue. A translucent splinter becomes opaque in nitric acid. In powder is completely decomposed by hydrochloric acid, forming a jelly of silica.

$\dot{R}^4\ddot{Si}^3 + 2\overset{\cdots}{Al}{}^2\ddot{Si}^3$, where $\dot{R}$ denotes $\dot{Na}$, $\dot{K}$, $\dot{Ca}$.

Analyses of the white varieties (nepheline), *a* from the Katzenbuckel by L. Gmelin, *b* from the Katzenbuckel by Scheerer, *c, d, e* from Monte Somma, all by Scheerer, *f* from Vesuvius by Arfvedson:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	43·36	43·70	44·03	44·29	44·04	44·11
Alumina	33·49	32·31	33·28	33·04	34·06	33·73

	a	*b*	*c*	*d*	*e*	*f*
Soda	13·36	15·83	15·44	14·93	15·91	20·46
Potash	7·13	5·60	4·94	4·72	4·52	—
Lime	0·90	0·84	1·77	1·82	2·01	—
Ox. of iron and man.	1·50	1·07	0·65	0·39	0·44	—
Water	1·39	1·39	0·21	0·21	0·21	0·62

Analyses of coloured varieties (elæolite) *g* from Friedrikswärn (green), *h* from Friedrikswärn (brown), *i*, *k* from Brevig (brown), *l*, *m* from Miask (white), all by Scheerer, *n* from Miask (white) by Bromeis :—

	g	*h*	*i*	*k*	*l*	*m*	*n*
Silica . . .	45·31	45·55	44·59	44·48	44·30	44·07	42·33
Alumina . .	32·63	32·00	32·14	32·03	33·25	33·12	34·39
Soda . . .	15·95	16·09	15·67	15·76	16·02	15·70	16·26
Potash . . .	5·45	5·02	5·10	5·24	5·85	5·69	5·95
Lime . . .	0·33	trace	0·28	0·24	0·32	0·26	0·47
Red ox. iron .	0·45	1·41	0·86	1·30	0·82	0·57	trace
Magnesia . .	—	—	—	—	0·07	trace	0·45
Water . . .	0·60	0·78	2·05	2·06	—	0·90	0·92

According to Bromeis and Scheerer, nepheline and elæolite contain traces of hydrochloric and sulphuric acids.

In attached and imbedded crystals and massive.

The white varieties (nepheline) are found on Monte Somma in matter ejected from Vesuvius, in a basaltic rock at Capo di Bove near Rome, in dolerite on the Katzenbuckel near Heidelberg, Meiges in Hessia, the Löbau mountain in Saxony, Miask. The coloured varieties (elæolite) in syenite near Laurvig and Brevig in Norway, near Miask in the Ural.

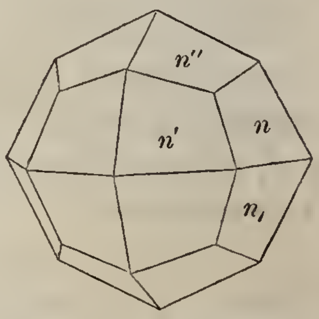
203. LEUCITE.—Leucite; Phillips. Amphigène; Hauy. Trapezoidaler Amphigen-Spath; Mohs. Leucit; Hausmann, Haidinger.

Cubic.

d 011 cleavage, *n* 211.

dd′	60°	0′
nd	54	44
nn,	48	11
nn′	33	33

FIG. 377.



Cleavage. *d*, very imperfect, extending a very small distance below the surface. Fracture conchoidal…uneven. Semi-transparent…translucent. Lustre vitreous; the surface of fracture resinous. R = 1·527. Greyish-white...ash-grey, yellowish and reddish-white. Streak white. Brittle. H = 5·5...6·0. G = 2·45...2·50.

Perfectly infusible before the blowpipe. With borax melts slowly into a transparent glass. With soda effervesces and forms a transparent blebby glass. With solution of cobalt becomes blue. In powder is completely decomposed by hydrochloric acid, leaving silica in powder.

$\dot{K}\ddot{Si} + \dddot{Al}\ddot{Si}^3$, silica 55·59, alumina 23·14, potash 21·27.

Analyses of leucite *a*, *b* from Vesuvius, *c* from Albano, *d* from Pompeii, all by Klaproth, *e* from Vesuvius by Arfvedson, *f* from Monte Somma by Awdejew :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	53·75	53·50	54	54·5	56·10	56·05
Alumina	24·63	24·25	23	23·5	23·10	23·03
Potash	21·35	20·09	22	19·5	21·15	20·40
Soda	—	—	—	($\ddot{Fe}$	0·95)	1·02

Is liable to decomposition, losing its lustre and transparency, and at last falling into powder.

In imbedded crystals and grains.

Is found in lava near Rome at Albano, Nemi, Borghetto, Viterbo, Acquapendente ; in lava around Vesuvius, Monte Somma, Pompeii ; in trachyte between Andernach on the Rhine and the lake of Laach ; in the dolerite of the Kaiserstuhl in Baden.

204. PORZELLANSPATH.—Porzellanspath ; Mohs, Hausmann, Haidinger.

Prismatic. *mm*′ = 88°.

Cleavage in two directions, at right angles to each other, bisecting the acute and obtuse angles between *m*, *m*′, not very perfect. Fracture uneven. Translucent on the edges. Lustre vitreous, inclining to pearly on the cleavage planes. Yellowish-white, greyish-white, light grey. Brittle. H = 5·5. G = 2·65...2·68. Phosphoresces when heated.

Before the blowpipe melts with intumescence into a blebby colourless glass. Is decomposed by concentrated hydrochloric acid.

$3\dddot{Al}\ddot{Si} + 3\dot{Ca}\ddot{Si} + \dot{Na}\ddot{Si}^3$, silica 50·6, alumina 28·1, lime 15·6, soda 5·7.

Analyses *a* by Fuchs, *b* by v. Kobell, *c* by Schafhäutl:—

	a	*b*	*c*
Silica	49·30	50·29	49·20
Alumina	27·90	27·37	27·30
Lime	14·42	13·53	15·48
Soda	5·46	5·92	4·53
Potash	—	0·17	1·23
Water	0·90	—	1·20
Chlorine	—	—	0·92

In crystals and granular masses.

The crystals are found imbedded in isolated blocks of felspar in the porcelain earth-pits at Obernzell near Passau, the massive varieties in a bed in granite near the same place.

Is decomposed by exposure, and transformed into friable porcelain earth, which frequently retains the form of the crystals.

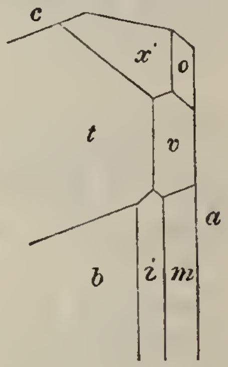
205. SPODUMENE.—Spodumene; Phillips. Triphane; Hauy. Prismatischer Triphan-Spath; Mohs. Triphan; Hausmann. Spodumen; Haidinger.

Oblique. 101,100 = 49° 50′; 111,010 = 45° 33′; 101,001 = 60° 40′.

a 100, *b* 010, *c* 001, *t* 011, *m* 110, *i* 130, *v* 111, *x* 112, *o* 212.

tb	39° 45′		*xb*	58° 0′	
cb	90 0		*xc*	45 9	
ib	17 33		*vc*	69 32	
mb	43 30		*mc*	103 57	
ab	90 0		*ta*	102 56	
ca	110 30		*va*	62 35	
vb	45 33		*xa*	78 48	
ob	63 53		*oa*	54 36	

FIG. 378.



Cleavage. *a*, perfect; *m*, not quite so perfect. Fracture uneven...splintery. Translucent...translucent on the edges. Lustre vitreous, inclining to pearly on the cleavage planes. Greenish-white...apple-green...light greenish-grey. Streak white. H = 6·5...7·0. G = 3·07...3·20.

Intumesces before the blowpipe, imparts a fleeting redness to the flame, and fuses easily into a transparent glass. With solution of cobalt becomes blue. Melted with fluor and bisulphate of potash it colours the flame red. Is dissolved in salt of phosphorus, leaving a skeleton of silica. Is not acted upon by acids either before or after ignition.

Analyses of spodumene from Utö *a* by Arfvedson, *b* by Stromeyer, *c* by Regnault, *d* by Hagen, *e* from Mexico, *f* from the Tyrol, both by Hagen:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	66·40	63·29	65·30	66·14	65·25	66·03
Alumina	25·30	28·78	25·34	27·02	27·56	26·45
Red oxide of iron . .	1·45	0·79	2·83	0·32	—	—
Lithia	8·85	5·63	6·76	3·84	not. det.	
Volatile matter . .	0·45	0·78	Soda	2·68		

In analyses *a*, *b*, *c* a mixture of lithia and soda appears to have been mistaken for pure lithia.

Is found in imperfect crystals, and cleavable masses, in a bed of iron ore in gneiss in the island of Utö, in granite at Sterzing and Lisens in the Tyrol, Killiney in Ireland, Peterhead in Scotland, Sterling and some other places in Massachusetts.

206. PETALITE.—Petalite; Phillips. Pétalite; Hauy. Prismatischer Petalin-Spath; Mohs. Petalit; Hausmann, Haidinger.

Cleavages parallel to three faces, *r*, *m*, *s*, in one zone; *s*, imperfect. $rm = 38° 25'$, $sm = 63° 0'$.

Fracture imperfect conchoidal. Translucent. Lustre vitreous; pearly on the planes of most perfect cleavage. White, passing into red, sometimes into green. Streak white. Brittle. H = 6·0...6·5. G = 2·38...2·43.

Before the blowpipe melts easily into an opaque blebby glass, colouring the flame red. The redness of the flame becomes very evident when petalite is fused with fluor and bisulphate of potash. With borax melts into a clear glass. Is not decomposed by acids.

Analyses of petalite from Utö *a* by Arfvedson, *b* by C. Gmelin, *c*, *d* by Hagen, *e* from Elba (castor) by Plattner:—

	a	*b*	*c*	*d*	*e*
Silica	79·21	74·17	77·81	77·07	78·01
Alumina	17·23	17·41	17·19	18·00	18·86
Lithia	5·76	5·16	2·69	2·66	2·76
Soda	—		2·30	2·27	trace
Lime	—	0·32	—	—	—
Loss by ignition . .	—	2·17	—	$\not{\mathrm{F}}\mathrm{e}$	0·61

In analysis *a*, the presence of soda in the mixture of lithia and soda was overlooked.

Is found in granular and compact masses in the island of Utö, at Bolton and Littleton in Massachusetts, near York on the north coast of lake Ontario, in attached crystals (castor) in granite in Elba.

207. POLLUX.—Pollux; Breithaupt, Hausmann.

Traces of cleavage. Fracture conchoidal. Transparent. Lustre vitreous, bright. Colourless, white. H = 6·0...6·5. G = 2·868...2·892.

Before the blowpipe becomes opaque. In thin splinters melts on the edges into a blebby enamel. Imparts a reddish-yellow colour to the outer flame. Easily soluble in borax forming a clear glass.

Analysis of a very small quantity by Plattner:—

Silica	46·20
Alumina	16·39
Red oxide of iron	0·86
Potash	16·51
Soda with a trace of lithia	10·47
Water	2·32

Is found with petalite in the drusy cavities of granite in Elba.

208. FELSPAR.—Felspar; Phillips. Feldspath (in part); Hauy. Orthotomer Feldspath; Mohs. Feldspath; Hausmann. Adular; Haidinger.

Oblique. 101,100 = 65°47′; 111,010 = 63° 7′; 101,001 = 50° 20′.

a 100, *b* 010, *c* 001, *y* 201, *r* 403, *x* 101, *q* 203, *w* $\bar{2}01$, *m* 110, *z* 130, *h* 023, *n* 021, *i* 061, *o* 111, *s* 131, *u* 221, *v* 241, *g* 112, *d* $\bar{2}41$, *e* $\bar{1}11$.

cb	90°	0′	*nb*	45°	3′	*eb*	72°	20′
ab	90	0	*hb*	71	36	*db*	49	10
ca′	63	53	*zb*	29	25	*zc*	102	29
ca	116	7	*mb*	59	24	*xm*	69	20
yc	80	22	*xb*	90	0	*xz*	78	23
rc	63	27	*ob*	63	7	*yz*	66	31
xc	50	19	*sb*	33	20	*oy*	39	27
qc	34	13	*ub*	57	0	*ny*	83	12
wc	41	0	*vb*	37	35	*dy*	113	12
ib	18	28	*gb*	74	28	*ym′*	134	19

my	45°	41′
yz	66	31
wm′	37	32
wz′	63	6
rm	58	31
rz	72	40
qm	83	2

or	29°	42′
gx	29	29
gm′	81	12
nw	57	43
ne	36	26
sn	33	1
mn	84	46

wm′	37°	32′
gc	29	8
oc	55	18
uc	81	56
mc	112	16
ec	33	30
cm′	67	44
qz	86	22
oz	55	1
vz	21	2
zn′	39	48
zg′	75	57

FIG. 379.

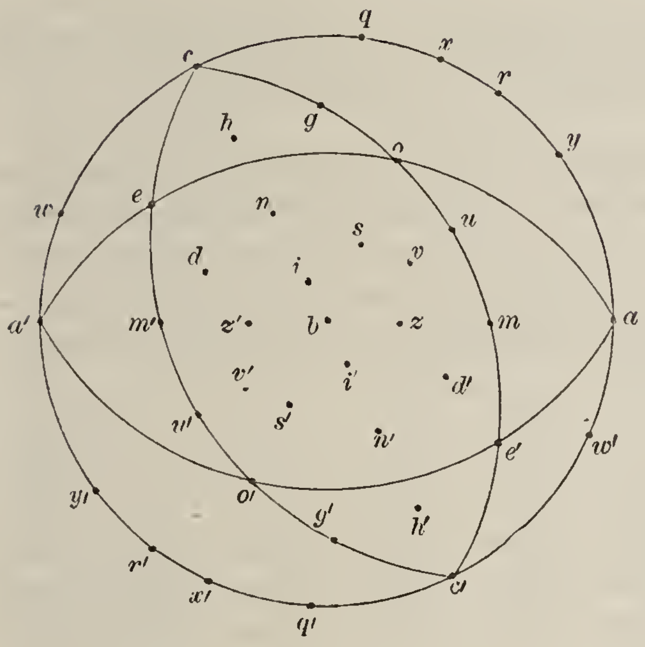


FIG. 380.

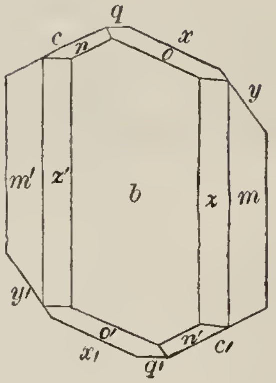


FIG. 381.

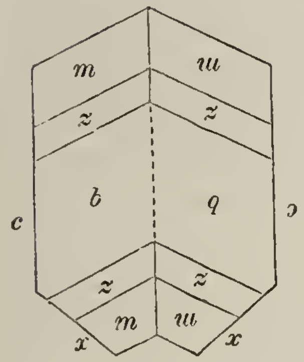


FIG. 382.

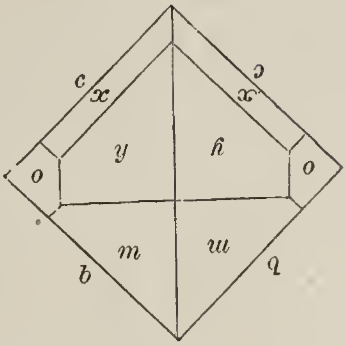
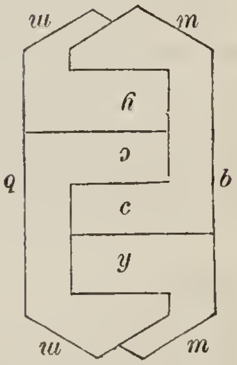


FIG. 383.



Combinations. *cm*, *xcm*, *xcmb..o.g.n.y.a.z*, *ycmb.x.o.n.z*, *qxoycmzb*, *oxcrymb*, *oxcyutb.nvwz*, *oxcneswmb*. The faces *m*, *z*, *b* striated parallel to their intersections with each other. Twins. 1. Twin-face *c* (fig. 381). 2. Twin-face *n* (fig. 382). 3. Twin-face *a* (fig. 383). 4. Twin-face *z*. Cleavage. *c*, very perfect. Faces of union exist also parallel to *c*. *b*, perfect, sometimes interrupted by conchoidal fracture, and rather difficult to obtain; *m*, traces. Fracture conchoidal...uneven. Transparent...translucent on the edges. Lustre vitreous. *c*, pearly.

R = 1·536, 1·764. The optic axes are in a plane parallel to *c*, and make angles of 58° 30′ with a normal to *b*. Colourless, white inclining to grey, green, brown, red, flesh-red, verdigris-green. Streak greyish-white. Brittle. H = 6·0. G = 2·53...2·59.

Melts with difficulty before the blowpipe into an opaque blebby glass. With borax forms a clear glass.. Soluble with difficulty in salt of phosphorus, leaving a skeleton of silica. With solution of cobalt the melted edges become blue. Is not acted on by acids.

$\dot{\mathrm{K}}\ddot{\mathrm{S}}\mathrm{i}^3 + \dddot{\mathrm{A}}\mathrm{l}\ddot{\mathrm{S}}\mathrm{i}^3$, silica 65·25, alumina 18·11, potash 16·64. Part of the potash is frequently replaced by soda and lime.

Analyses of the transparent colourless varieties (adularia) *a* from St. Gotthardt, G = 2·5756, by Abich, *b* by Awdejew, *c* by Berthier, *d* from the Valenciana mine in Mexico (Breithaupt's valencianite) by Plattner, *e* of flesh-coloured felspar from Lomnitz by V. Rose, *f* of opalescent felspar from Dawlish (murchisonite) by R. Phillips :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	65·69	65·75	64·20	66·82	66·75	68·6
Alumina	17·97	18·69	18·40	17·58	17·50	16·6
Potash	13·99	14·17	16·95	14·80	12·00	14·8
Soda	1·01	1·44	$\bar{\mathrm{F}}\mathrm{e}$	0·09	1·75	—
Lime	1·34	—	—	—	1·25	—

Analyses of greyish or yellowish transparent varieties in imbedded crystals showing the forms *b*, *c*, *x*, *m*, *n* (glassy felspar or sanidine) *g* from Vesuvius by G. Rose, *h* from the Drachenfels, *i* from Mont d'Or, both by Berthier, *k* from Epomeo in Ischia, *l* from Arso in Ischia, *m* from the tufa of Pausilipo, all by Abich :—

	g	*h*	*i*	*k*	*l*	*m*
Silica	65·52	66·6	66·1	66·73	65·00	67·87
Alumina	19·15	18·5	19·8	17·36	18·64	15·72
Red oxide of iron . .	—	0·6	—	0·81	0·83	2·41
Potash	14·74	8·0	6·9	8·27	9·12	6·68
Soda		4·0	3·7	4·10	3·49	3·86
Lime	0·60	1·0	—	1·23	1·23	3·16
Magnesia	—	—	2·0	1·20	1·03	1·40
Oxide of mangan. . .	—	—	—	—	0·13	—

Analyses of felspar *n* from Alabaschka, *o* from Schaitansk by Moss and Litton, *p* from Martersberg near Marienberg, G = 2·44, by Kröner, *q* from Freiberg by Kersten, *r* from Mulde near Freiberg by Moll, *s* (Breithaupt's mikroklin) by Evreinoff :—

	n	*o*	*p*	*q*	*r*	*s*
Silica	65·91	65·82	66·43	65·52	65·75	65·76
Alumina	20·93	19·00	17·03	17·61	17·72	18·31
Red oxide of iron . .	—	—	0·49	0·80	—	—
Potash	10·18	12·25	13·96	12·98	12·05	14·06
Soda	3·50	3·30	0·91	1·70	3·66	—
Lime	0·11	0·34	1·03	0·94	0·82	1·20
Magnesia	—	0·07	—	—	—	—

Analyses of felspar *t* (G = 2·5552) from Baveno, *u* green felspar (amazon-stone, G = 2·5816) from Siberia, both by Abich, *v* green crystallized felspar (G = 2·546...2·549) from Bodenmais by Kerndt, *w*, *x* of nodules resembling glassy felspar in the trachyte of Hohenhagen near Dransfeld in Hanover by Schnedermann, *y* flesh-red felspar (G = 2·576...2·579) from Bathurst in Canada (Thomson's perthite) by T. S. Hunt :—

	t	*u*	*v*	*w*	*x*	*y*
Silica	65·72	65·32	63·66	64·86	64·86	66·44
Alumina	18·57	17·89	17·27	21·46	21·92	18·35
Potash	14·02	13·05	10·66	2·62	4·15	6·37
Soda	1·25	2·81	5·14	10·29	7·53	5·56
Lime	0·34	0·10	0·39	—	—	0·67
Magnesia . . .	0·10	0·09	2·28	—	—	0·24
Protox. iron . .	(with $\dot{\mathrm{Cu}}$	0·30)	0·45	—	—	$\dot{\bar{\mathrm{Fe}}}$ 1·00
Ox. mangan. . .	—	0·19	0·15	—	—	$\dot{\mathrm{H}}$ 0·40

Analyses of felspar *z* from Chamouni, *α* from the syenite of the Ballon de Servance in the Vosges, both by Delesse, *β* of milk-white, translucent moon-stone, slightly decomposed, from Ceylon, *γ* of the same decomposed, pearly, both by Brongniart, *δ* of partially decomposed felspar from the Auersberg in the Harz by Rammelsberg, *ε* from Laurvig (G = 2·5872), *ζ* from Friedrichswärn, exhibiting a play of sky-blue light, both by C. Gmelin :—

	z	*α*	*β*	*γ*	*δ*	*ε*	*ζ*
Silica . . .	66·48	64·26	64·00	67·10	66·26	65·90	65·19
Alumina . .	19·06	19·27	19·43	17·83	16·98	19·46	19·99
Potash . . .	10·52	10·58	14·81	13·50	14·42	6·55	7·03
Soda . . .	2·30	2·88	—	—	0·20	6·14	7·08
Lime . . .	0·63	0·70	0·42	0·50	0·43	0·28	0·48
Magnesia . .	—	0·77	0·20	trace	0·11	—	—
Red ox. iron .	—	0·50	—	—	0·31	0·44	0·63
Water . . .	—	0·40	1·14	1·07	1·29	0·12	0·38

In attached and imbedded crystals, crystalline and granular masses.

Adularia and the nearly opaque common felspar are found in plutonic and metamorphic rocks; the transparent varieties having a bright vitreous lustre, in imbedded crystals, having but few faces, and traversed by numerous cracks, called glassy felspar or sanidine, in volcanic rocks. It has been observed that common felspar exposed to a high temperature in the inner wall of a furnace has acquired the appearance of glassy felspar. Adularia is found in St. Gotthardt, Mont Blanc, Dauphiné, Arendal in Norway, in the granite of Arran, in veins in slate at Tintagel in Cornwall, on Snowdon. A variety exhibiting a play of colours was found in Ceylon, in the zircon syenite of the south of Norway, in Greenland. Common felspar in attached crystals at Baveno on the Lago Maggiore, Lomnitz in Silesia, the Morne mountains in Ireland, Alabaschka near Mursinsk and several other places in the Ural, in imbedded crystals at Karlsbad and Elbogen in Bohemia, Ochsenkopf, Kossein and Kirchenlamitz in the Fichtelgebirge, Eglersburg in Thuringia, near Rio Janeiro in the Brazils. Green felspar (amazon-stone) is found on the east side of Lake Ilmen. Glassy felspar occurs in trachyte in the Drachenfels on the Rhine, Mont d'Or and other places in Auvergne, in Mexico, Chile; at Oberbergen, Bischoffingen and Rothweil in Baden, in Hungary, the Euganean hills, Milo, Kamtschatka, Sitka, in trachytic lava at Montamiata, Viterbo, Potzzuolo, Ischia in Italy, in Iceland; in the basaltic conglomerate of Dörenberg near Cassel; in volcanic masses about Vesuvius and the lake of Laach, in Rum, in pitch-stone in Arran. The murchisonite of Levy is a flesh-red variety of felspar ($G = 2{\cdot}51$) occurring in rolled pebbles at Heavitree near Exeter, which has, besides the usual cleavages c, b, at right angles to each other, a third cleavage δ, such that $\delta b = 90° \; 0'$, $\delta c = 106° \; 50'$, $\delta a = 9° \; 17'$. An opalescent play of light is observable on the cleavage planes δ. Some of the crystals are twins, the twin-face being a. The transparent colourless felspar from Ceylon (moon-stone) and the iridiscent felspar from Friedrichswärn have the same cleavages and play of light. Crystals of flesh-red felspar having the faces b, m and probably either c, x or y, have been formed in a copper furnace in Mannsfeld; and crystals, perfectly resembling the adularia from St. Gotthardt, having the faces b, c, m, and sometimes a and z, both single and in twins (twin-face c), were found by the younger Hausmann between five and six feet above the hearth of an iron furnace at Josephshütte near Stolberg.

Felspar is liable to suffer decomposition, forming a silicate of potash soluble in water, which is washed away, leaving a hydrous silicate of alumina (porcelain-clay or kaolin). It is sometimes converted into a substance like steatite, or into a mechanical mixture of nearly equal parts of carbonate of lime and silicate of alumina and red oxide of iron.

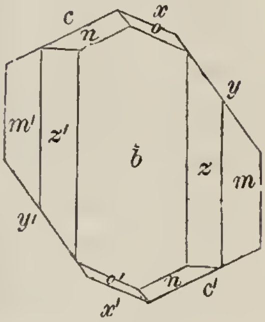
209. RHYACOLITE.—Empyrodoxer Feld-Spath; Mohs. Ryacolith; Hausmann, Haidinger.

Oblique. 101,100=65° 37′·3; 111,010=63° 19′; 101,001=50° 28′·6.

a 100 twin-face, *b* 010, *c* 001, *n* 021, *x* 101, *y* 201, *o* 111.

bc	90°	0′	*ob*	63°	19′
ab	90	0	*yo*	39	19
ca	116	6	*on*	43	56
xc	50	29	*mo*	56	58
yc	80	28	*oc*	55	21
ym	45	26	*cm′*	67	41
nb	45	16	*xm*	69	8
zb	29	41	*xbm*	65	37
mb	59	41	*ybm*	35	37

FIG. 384.



Combinations. *oxcmb*, *xcnymb*, *oxcnymzb*. Twin crystals. 1. Twin-face *a*. 2. Twin-face *n*. *cɔ* = 89° 28′. Cleavage. *c*, perfect; *b*, less perfect, yet distinct. Fracture conchoidal. Transparent...translucent. Lustre vitreous. Colourless, white, greyish, yellowish. Streak white. Very brittle. H = 6·0. G = 2·57...2·62.

Before the blowpipe is rather more fusible than felspar, and imparts a yellow colour to the flame. Is decomposed by hydrochloric acid leaving a residue of silica in powder.

$\dot{\mathrm{R}}\ddot{\mathrm{S}}\mathrm{i} + \dddot{\mathrm{A}}\mathrm{l}\ddot{\mathrm{S}}\mathrm{i}^2$, where $\dot{\mathrm{R}}$ is soda, potash and lime.

Analysis by G. Rose:—

Silica	50·31
Alumina	29·44
Red oxide of iron . . .	0·28
Lime	1·07
Magnesia	0·23
Potash	5·92
Soda	10·56

Is found in small transparent crystals in volcanic matter at the foot of Vesuvius, in imbedded crystals in the lavas of the Eiffel, and at the lake of Laach.

210. ALBITE.—Albite; Phillips, Beudant. Heterotomer Feld-Spath, Tetartoprismatischer Feld-Spath; Mohs. Albit; Hausmann. Albit, Periklin; Haidinger.

Anorthic. $\bar{1}\bar{1}0,\bar{1}10 = 57° 45'$; $0\bar{1}0,\bar{1}\bar{1}0 = 60° 8'$; $001,\bar{1}10 = 64° 55'$; $1\bar{1}1,001 = 57° 37'$; $\bar{1}\bar{1}0,001 = 69° 9'$.

m 010, *p* 001, *e* 021, *n* $0\bar{2}1$, *x* 101, *y* 201, *l* 110, *t* $\bar{1}10$, *z* 130, *f* $\bar{1}30$, *s* 111, *o* $1\bar{1}1$, *k* 112, *g* $1\bar{1}2$.

tm	62° 7′	*sm*	59° 33′	*pl′*	69° 9′
lm	60 8	*xs*	25 19	*te*	52 19
lt′	57 45	*ox*	27 19	*es*	42 46
fm	31 30	*om′*	67 49	*sy*	39 27
zm	30 48	*tp*	64 55	*yt′*	45 28
mp	86 24	*pg*	29 55	*ly*	41 26
pm′	93 36	*go*	27 42	*yo*	39 0
np	46 5	*ot′*	57 28	*on*	48 4
ep	42 34	*sl*	55 7	*nl′*	51 30
xp	52 37	*ks*	25 54	*tmp*	63 26
yx	29 46	*pk*	29 50	*lmx*	63 49

FIG. 385.

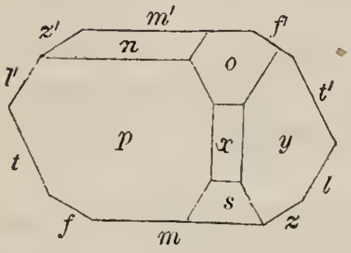


FIG. 386.

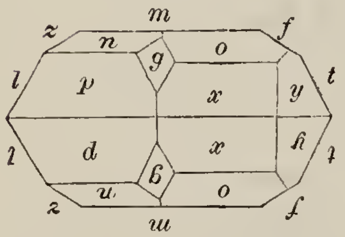
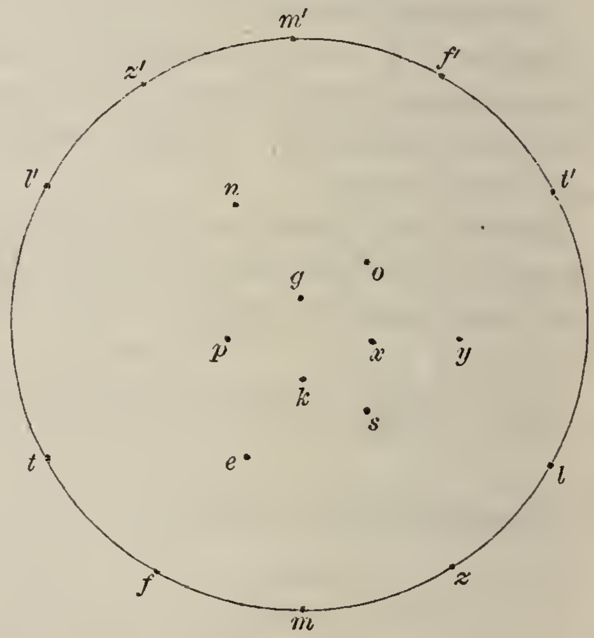


FIG. 387.



Combinations. *xoptlm*, *xyognpltfzm*, *xsonptlzfm*. Twins. 1. Twin-face *m* (fig. 386). $pd = - 7° 12'$. $xx = - 10° 16'$. 2. Twin-axis the axis of the zone *tml*. 3. Twin-axis the axis of the zone *pxy*. Cleavage. *p*, very perfect; *m*, less perfect; *t*, imperfect. Fracture imperfect conchoidal...uneven. The faces *f*, *z*, *m*, *t*, *l* striated parallel to their intersections with each other; *x* usually uneven, rough. Transparent...translucent on the edges. Lustre vitreous; on cleavage faces, especially *p*, pearly. Colourless, white of various shades, light red, yellow, green, grey. Streak white. Brittle. H = 6·0...6·5. G = 2·54...2·64.

Melts with difficulty before the blowpipe and colours the flame distinctly yellow. Is not decomposed by acids.

$\dot{N}a\ddot{S}i^3 + \dddot{A}l\ddot{S}i^3$, silica 69·20, alumina 19·20, soda 11·60. A small portion of the soda is usually replaced by lime and potash.

Analyses of albite *a* from Finbo by Eggertz, *b* from Finland by Tengström, *c* from Penig by Ficinus, *d* from Arendal by G. Rose, *e* from Chesterfield in North America by Stromeyer, *f* from St. Gotthardt, in crystals (pericline), by Thaulow:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	70·48	67·99	67·75	68·46	70·68	69·00
Alumina	18·45	19·61	18·65	19·30	19·80	19·43
Red oxide of iron . .	—	0·70	0·95	0·28	0·11	—
Oxide of manganese .	—	—	0·25	—	—	—
Lime	0·55	0·66	($\dot{M}g$ 0·34)	0·68	0·23	0·20
Soda	10·50	11·12	10·06	9·12	9·06	11·47

Analyses of albite *g* from the greenstone of Miask, in crystals (G = 2·624) by Abich, *h* from Brevig in Norway, by Erdmann, *i* from Pantellaria in trachyte (G = 2·595) by Abich, *k* from Schreibersau in the Riesengebirge, in crystals (G=2.624), by Lohmeyer, *l* from Freiberg, *m* from Marienbad, G = 2·612, both by Kersten:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	68·45	69·11	68·23	68·75	67·92	68·70
Alumina	18·71	19·34	18·30	18·70	18·50	17·92
Red oxide of iron . .	0·27	0·62	1·01	0·90	0·50	0·72
Lime	0·50	—	1·26	0·39	0·85	0·24
Magnesia	0·18	—	0·51	0·09	0·42	—
Soda	11·24	10·98	7·99	10·90	8·01	11·01
Potash	0·65	0·65	2·53	1·21	2·55	1·18

Analyses of albite *n* from Arendal (G = 2·63...2·66) mean of three analyses by Rammelsberg, *o* from Pennsylvania, mean of three analyses by Redtenbacher, *p* from Perth in Canada (Thomson's peristerite, G = 2·625...2·627) by T. S. Hunt, *q* in white crystals from Snarum by Scheidhauer, *r* granular, perhaps a mechanical mixture of albite and felspar, from St. Gotthardt by Brooks:—

	n	*o*	*p*	*q*	*r*
Silica	67·62	67·20	66·80	66·11	67·39
Alumina	16·59	19·64	21·80	18·96	19·24
Red oxide of iron . .	2·30	—	0·30	0·34	—
Lime	0·85	1·44	2·52	3·72	0·31
Magnesia	1·46	0·31	0·20	0·16	0·61
Soda	10·24	9·91	7·00	9·24	6·23
Potash	0·51	1·57	0·58	0·57	6·77
Water	0·69	—	0·60	—	—

In attached crystals and cleavable or granular masses, in granite, gneiss, greenstone, lava.

Is found at Auris in Dauphiné and Montagne de Lis near Barèges in the Pyrenees, Baveno in Italy on felspar, Bobritzsch near Freiberg, Borstendorf, Siebenlehn, Penig and Zöblitz in Saxony, Langenbielau and near Hirschberg in Silesia, Gastein and Hüttenwinkel in Salzburg, Andreasberg and Steinberg near Goslar in the Harz, on the Rohrberg and Greiner, the Schmunerthal, Pfundersthal and Pfitscherjoch in the Tyrol, Rozena and near Bobruwka in Moravia, Wittichen in Baden, Greenland, Kerabinsk near Miask and Alabaschka near Mursinsk in Siberia, the Saualpe in Carinthia, St. Gotthardt and other places in the Alps, Kimito in Finland, Broddbo and Finbo in Sweden, Tintagel in Cornwall, in syenite and greenstone near Edinburgh, the Morne mountains in Ireland, Upper Egypt, Chesterfield and Wilmington in Massachusetts, Almada in the Brazils.

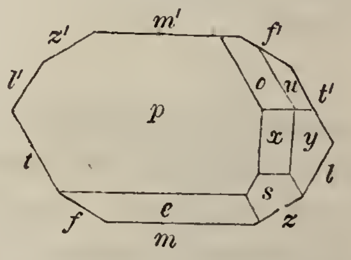
211. OLIGOCLASE.—Oligoclase; Dufrénoy. Antitomer Feld-Spath; Mohs. Oligoklas; Hausmann, Haidinger.

Anorthic.

m 010, *p* 001, *e* 021, *n* $0\bar{2}1$, *x* 101, *y* 201, *l* 110, *t* $\bar{1}10$, *z* 130, *f* $\bar{1}30$, *s* 111, *o* $1\bar{1}1$, *u* $2\bar{2}1$. The face *n* truncates the edge *pm′*.

mp	86°	45′
pt	64	30
lt	60	nearly.

FIG. 388.



Combinations. *xpenzfm*, *xposeyutlzfm*. Twins. 1. Twin axis the axis of the zone *xp*. 2. Twin-face *m*. The massive varieties are frequently composed of numerous pairs of twins giving a striated appearance to the cleavages *p*. Cleavage. *p*, perfect; *m*, less perfect; *l*, imperfect. Fracture conchoidal ...uneven, splintery. More or less translucent. Lustre vitreous, on the more perfect cleavage faces inclining to pearly, on the other faces inclining to waxy. Greenish-white...leek-green, greenish-grey, reddish-grey, flesh-red. Streak white. H = 6·0. G = 2·63...2·74.

Melts before the blowpipe much more easily than felspar and albite into a white porous glass. Is not decomposed by acids.

$\dot{Na}^2\ddot{Si}^3 + 2\dddot{Al}\ddot{Si}^3$, a considerable part of the soda being replaced by lime, potash and magnesia.

Analyses of oligoclase *a* from Danvikszoll near Stockholm, *b* from Ytterby, both by Berzelius, *c* from Arendal by Hagen, *d* from Ajatskaja to the north of Katharinenburg by Francis, *e* from Arendal by Rosales, *f* from Schaitansk in the Ural by Bodemann:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	63·70	61·55	63·51	61·06	62·70	64·25
Alumina	23·95	23·80	23·09	19·68	23·80	22·24
Red oxide of iron .	0·50	—	—	4·11	0·62	0·54
Lime	2·05	3·18	2·44	2·16	4·60	2·57
Magnesia	0·65	0·80	0·77	1·05	0·02	1·14
Soda	8·11	9·67	9·37	7·55	8·00	7·98
Potash	1·20	0·38	2·19	3·91	1·05	1·06

Analyses of oligoclase *g* from Warmbrunn in Silesia by Rammelsberg, *h* from Kimito in Finland (G = 2·63) by Chodnew, *i* from a boulder at Flensburg (G = 2·651) by Wolff, *k* from Tvedestrand in Norway, *l* from the gneiss of the deep Fürstenstolle near Freiberg (G = 2·63...2·65), *m* from Marienbad in Bohemia (G = 2·631), both by Kersten:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	63·94	63·80	64·30	61·30	62·97	63·20
Alumina	23·71	21·31	22·34	23·77	23·48	23·50
Red ox. iron . . .	traces	—	—	0·36	0·51	0·31
Lime	2·52	0·47	4·12	4·78	2·83	2·42
Magnesia	traces	—	—	—	0·24	0·25
Soda	7·66	12·04	9·01	8·50	7·24	7·42
Potash	2·17	1·98	—	1·29	2·42	2·22

Analyses of oligoclase *n* from the volcanic rocks of Teneriffe (G = 2·58...2·59) by Deville, *o* from Arriège by Laurent, *p* from Boden near Marienberg (G = 2·66...2·68) by Kerndt, *q* from Mellandamsbacken near Sahla (G = 2·69) by Svanberg, *r* from the protogyne of Chamouni by Delesse, of hafnefjordite *s* from Hafnefjord (G = 2·729) by Forchhammer:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	62·97	62·6	61·96	59·66	63·25	61·22
Alumina . .	22·29	24·6	22·66	23·28	23·92	23·32
Red ox. iron .	—	0·1	0·35	1·18	—	2·40
Lime	2·06	3·0	2·02	5·17	3·23	8·82
Magnesia . .	0·54	0·2	0·11	0·36	0·32	0·36
Soda	8·45	8·9	9·43	5·61	6·88	2·56
Potash . . .	3·69	—	3·08	1·75	2·31	trace
Loss by ignit. .	—	—	(Mn 0·39)	1·02	—	—
Not decomp. .	—	—	—	0·82	—	—

Crystallized and massive, in granite, syenite, gneiss, porphyry, basalt.

Is found massive in granite near Stockholm, Ytterby, Trollhätta, Tvedestrand in Norway (avanturine-felspar or sonnenstein, the play of colours being produced by numerous thin hexagonal plates of hematite), Kimito and other parts of Finland, Schaitansk in the Ural, Philadelphia in the United States; in attached crystals at Arendal in Norway, in imbedded crystals in the porphyry of Ajatskaja and Bogoslowsk in the Ural, in the green porphyry of the Mühlenthal near Elbingerode in the Harz, in the porphyry called Verde Antico in the Morea. Hafnefjordite is found in cavities in lava, with augite and ilmenite, at Hafnefjord in Iceland.

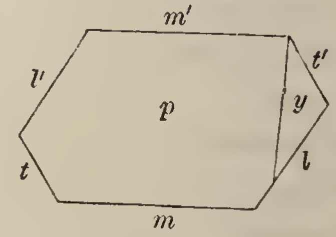
212. LABRADORITE.—Labrador felspar; Phillips. Feldspath opalin; Hauy. Polychromatischer Feld-Spath; Mohs. Labradorit; Hausmann, Haidinger.

Anorthic.

m 010, *p* 001, *l* 110, *t* $\bar{1}10$, *y* 201.

mp	86°	25′
lp	114	26
pl′	65	34
lm	59	20

FIG. 389.



Twins. 1. Twin-face *m*. 2. Twin-face *p*. Massive varieties are sometimes constituted of numerous layers of which each pair is a twin-crystal according to one of the two laws above stated. Cleavage. *p* very perfect; *m* rather less perfect; *l* imperfect. Fracture imperfect conchoidal… uneven, splintery. Faintly translucent. Lustre vitreous in-

clining to pearly on the faces of most perfect cleavage, and to resinous on the surfaces of fracture. Grey passing into yellow, red, green, white; ash-grey, smoke-grey, flesh-red. The colours of the face *b* sometimes changeable. The play of colours appears to be produced by a number of microscopic crystals of some other mineral, perhaps quartz, contained in the labradorite. Streak white. Brittle. H = 6·0. G = 2·67...2·76.

Melts before the blowpipe rather more easily than felspar, into a colourless glass. In powder is completely decomposed by concentrated hydrochloric acid.

$\dot{R}\ddot{S} + \dddot{Al}\ddot{S}^2$, where $\dot{R}$ is principally lime and soda.

Analyses of labradorite *a* from the island of St. Paul, *b* from Russia, both by Klaproth, *c* from a boulder in Brandenburg by Dulk, *d* from Campsie in Scotland, *e* from Milngavie near Glasgow, both by Le Hunte, *f* from the lava of Ætna by Abich:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	55·75	55·00	54·66	54·67	52·34	53·48
Alumina	26·50	24·00	27·87	27·89	29·97	26·46
Red ox. iron	1·25	5·25	—	0·31	0·87	1·60
Lime	11·00	10·25	12·01	10·60	12·10	9·49
Magnesia	—	—	—	0·18	—	1·74
Soda	4·00	3·50	5·46	5·05	3·97	4·10
Potash	—	—	—	0·49	0·30	0·22
Protox. mang.	—	—	—	—	—	0·89
Water	0·50	0·50	—	—	—	0·42

Analyses of labradorite *g* from Kijew by Segeth, *h* from Russgarden in the parish of Tuna in Dalarne by Svanberg, *i* from the doleritic porphyry of the Faröe islands (G = 2·67... 2·69) by Forchammer, *k* (G = 2·71), *l* (G = 2·72), *m* (G = 2·705), all from Egersund by Kersten:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	55·49	52·15	52·52	52·30	52·45	52·20
Alumina	26·83	26·82	30·03	29·00	29·85	29·05
Red ox. iron	1·60	1·29	1·72	1·95	1·00	0·80
Lime	10·93	9·15	12·58	11·69	11·70	12·10
Magnesia	0·15	1·02	0·19	0·15	0·16	0·13
Soda	3·97	4·64	4·51	4·01	3·90	4·70
Potash	0·36	1·79	—	0·50	0·60	
Water	0·51	1·75	—	—	—	—

Analyses of labradorite *n* from Drummond in Canada by T. S. Hunt, *o* from the porphyry of Tyfholms Udden near Holmen in Norway, *p* from the melaphyr between Botzen and Collman in the Tyrol, both by Delesse :—

	n	*o*	*p*
Silica	54·70	55·70	53·23
Alumina	29·80	25·23	27·73
Red oxide of iron . .	0·36	1·71	1·50
Magnesia	—	0·72	0·93
Lime	11·42	4·94	8·28
Soda	2·44	7·04	7·38
Potash	0·23	3·53	
Water	0·40	0·77	0·95

Labradorite occurs principally as a constituent of rocks with augite, diallage, hypersthene. The varieties which exhibit a play of colours are mostly derived from a coarse-grained hypersthene rock.

It is found on the coast of Labrador, in the island of St. Paul, in Russia near Peterhof in Ingermannland, Kijew, in Finland at Ojamo and Miolö, in the Morne mountains in Ireland, Monzoni in the Tyrol, in the Harz, in the duchy of Brandenburg in boulders, in greenstone porphyry at Campsie and Milngavie near Glasgow, Vico in Corsica, Neustadt near Stolpen in Saxony, Wiesbühl near Lobenstein in the principality of Reuss, in dolerite at Penig, Rosswein, Siebenlehn in Saxony, the Meissner in Hessia, and the island of Skye, in hornblende rock at Russgarden in Dalarne in Sweden, in the doleritic porphyry of the Faröe islands, and at Egersund in Norway, in lava on Monte Pilieri near Nicolosi on Ætna, in the lava of Vesuvius.

213. CHRISTIANITE. — Anorthite ; Phillips, Beudant. Anorthomer Feld-Spath ; Mohs. Anorthit ; Hausmann, Haidinger.

Anorthic. $\bar{1}\bar{1}0,\bar{1}10 = 59^\circ\ 30'$; $0\bar{1}0,\bar{1}\bar{1}0 = 62^\circ\ 32'$; $001,\bar{1}10 = 65^\circ\ 38'$; $1\bar{1}1,001 = 58^\circ\ 10'$; $\bar{1}\bar{1}0,001 = 69^\circ\ 3'$.

m 010, *p* 001, *e* 021, *n* $0\bar{2}1$, *x* 101, *y* 201, *i* $\bar{2}01$, *q* 203, *l* 110, *t* $\bar{1}10$, *z* 130, *f* $\bar{1}30$, *s* 111, *o* $1\bar{1}1$, *r* $\bar{1}11$, *u* $2\bar{2}1$, *w* 241, *v* $2\bar{4}1$.

mp	85° 48′	pt'	114° 22′	*zm*	30° 59′
pl	110 57	tl'	59 30	*fm*	29 27
pl'	69 3	*mt*	57 58	nm'	47 25
pt	65 38	*lm*	62 32	*np*	46 47

ep	42°	38′	*om′*	64°	40′	*yml*	34°	43′
em	43	10	*um′*	57	15	*qml*	81	26
qp	34	48	*vp*	88	4	*imt*	22	32
xp	51	33	*vm′*	38	6			
yp	81	31	*wp*	81	23			
ip	41	14	*wm*	38	38			
op	58	10	*sp*	54	22			
up	85	7	*pml*	116	14			
rp	45	14	*xml*	64	41			

FIG. 390.

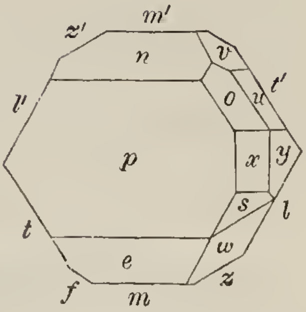


FIG. 391.

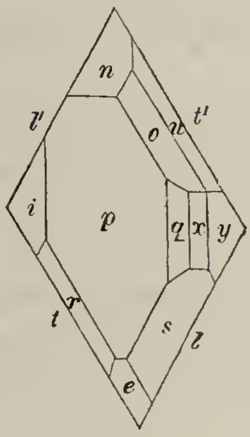


FIG. 393.

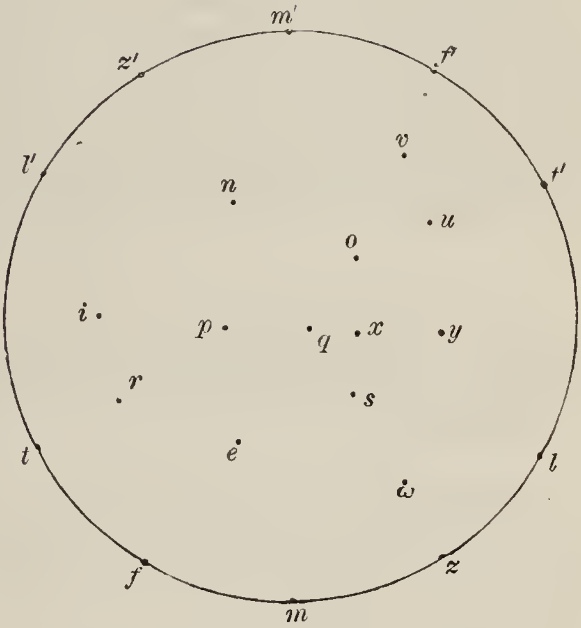
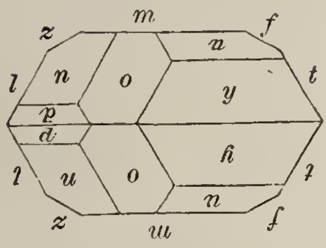


FIG. 392.



Combinations. *ptlsoney.uxqri*, *xsoypeitlm*, *xsoyuvwnepiltfzm*. Twins. Twin-face *m* (fig. 392). *pd* = − 8° 24′. Cleavage. *p*, *m*, perfect. Fracture conchoidal. Transparent...translucent. Lustre vitreous, on the cleavage faces pearly. Colourless, white. Streak white. Brittle. H = 6·0. G = 2·656...2·763.

Melts with difficulty before the blowpipe into a blebby glass. With soda forms an opaque white glass. Is completely decomposed by hydrochloric acid, leaving silica in powder.

$\dot{\mathrm{Ca}}\ddot{\mathrm{Si}} + \dddot{\mathrm{Al}}\ddot{\mathrm{Si}}$, silica 43·72, alumina 36·40, lime 19·88. Part of the lime is usually replaced by magnesia, potash and soda.

Analyses of christianite *a* from Monte Somma by G. Rose, *b*, *c* from Monte Somma by Abich, *d* from the lava of Java by Reinwardt, *e* from Selfjall near Lamba in Iceland (G = 2·70), not quite free from a mixture of augite, by Forchammer, *f* from lava in the plain of Thjorsa in Iceland (G = 2·688) by Genth:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	44·49	44·12	43·79	46·0	47·63	48·75
Alumina	34·46	35·12	35·49	37·0	32·52	30·59
Red oxide of iron	0·74	0·70	0·57	—	2·01	1·50
Lime	15·68	19·02	18·93	14·5	17·05	17·22
Magnesia	5·26	0·56	0·34	—	1·30	0·97
Soda	—	0·27	0·68	0·6	1·09	1·13
Potash	—	0·25	0·54	—	0·29	0·62

Is found in crystals and massive, with other volcanic minerals, in cavities in scattered blocks of dolomite on Monte Somma near Vesuvius, in Java in lava, in Iceland, at Paras in Columbia, in the meteoric stones that fell at Juvenas.

Having used the term 'anorthic' to denote the system of crystallization to which the crystals of this substance belong, and, as the name 'anorthite' might with equal propriety have been applied to every other member of the system, we have been induced to adopt the name of 'christianite,' assigned to certain crystals of it by M. Monticelli, to designate this mineral.

214. LATROBITE.—Latrobite; Phillips, Beudant. Latrobit; Mohs, Hausmann, Haidinger.

Anorthic.

Cleavage, in three directions, making with each other angles of 86° 30′, 78° 15′ and 71° 0′. Fracture uneven. Translucent. Lustre vitreous, inclining to pearly. Pale red. H = 5·0...6·0. G = 2·720...2·722.

Becomes white before the blowpipe, and melts with intumescence on the edges. With borax fuses into a clear glass.

Analyses by C. Gmelin:—

Silica	44·65	41·78
Alumina	36·81	32·83
Lime	8·28	9·79
Potash	6·58	6·58
Oxide of manganese	3·16	5·77
Magnesia	0·63	
Water	2·04	2·04

In imperfect crystals; massive; disseminated.

Is found with felspar, mica and calcite on the island of Amitok near the coast of Labrador. It is said to occur also at Bolton in Massachusetts.

215. BARSOWITE.—Barsowit; Hausmann, Haidinger.

Cleavage in one direction tolerably perfect. Fracture splintery. Translucent on the edges. Lustre pearly...dull. White. H = 5·3...6·0. G = 2·74...2·752.

Before the blowpipe melts with difficulty on the edges into a blebby glass. With borax melts into a colourless transparent glass. With salt of phosphorus leaves a skeleton of silica. With solution of cobalt turns blue. Is easily decomposed by warm hydrochloric acid forming a jelly of silica.

$\dddot{Al}^2\ddot{Si}^3 + 2\dot{Ca}\ddot{Si}$, part of the $\dot{Ca}$ being replaced by $\dot{Mg}$.

Analyses by Varrentrapp :—

Silica	49·01	49·05	48·07
Alumina	33·85	33·78	34·08
Lime	15·46	15·30	15·10
Magnesia	1·55	1·42	1·65

Is found in granular and compact masses, in blocks containing corundum, spinelle and mica, in the auriferous sand of Barsowskoi near Kyschtimsk in the Ural.

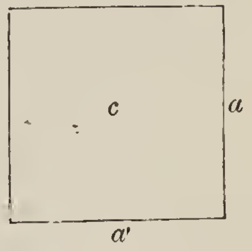
216. GEHLENITE.—Gehlenite; Phillips, Hauy. Pyramidaler Adiaphan-Spath; Mohs. Gehlenit; Hausmann, Haidinger.

Pyramidal.

a 100, *c* 001.

ac	90°	0′
aa′	90	0

FIG. 394.



Cleavage. *c*, imperfect, but distinct; *a*, traces. Fracture imperfect conchoidal...uneven. Faces rough, uneven. Translucent on the edges. Lustre resinous, inclining to vitreous. Grey, brown, green. Streak white. Not very brittle. H = 5·5...6·0. G = 2·99...3·10.

Before the blowpipe fusible in thin splinters with great difficulty. With borax and salt of phosphorus fuses into a glass coloured by iron. Is completely decomposed, both before and after ignition, by warm hydrochloric acid, forming a jelly of silica.

$\dot{Ca}^3\ddot{Si} + \dddot{Al}\ddot{Si}$, part of the $\dot{Ca}$ being replaced by $\dot{Mg}$, $\dot{Fe}$, and part of the $\dddot{Al}$ by $\dddot{\bar{Fe}}$.

Analyses *a* by Fuchs, *b* by v. Kobell, *c* by Damour, *d*, *e* by Kühn, *f* by Rammelsberg :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	29·64	31·0	31·60	30·47	29·52	29·78
Alumina	24·80	21·4	19·80	17·79	19·00	22·02
Red oxide of iron . .	6·56	—	5·97	7·30	—	3·22
Protoxide of iron . .		4·4	—	—	7·25	1·73
Lime	35·30	37·4	38·11	36·97	36·55	37·90
Magnesia	—	3·4	2·20	2·99	1·41	3·88
Soda	—	—	0·33	—	$\dot{Mn}$	0·19
Water	3·30	2·0	1·53	3·62	5·55	1·28

In *a* the whole of the iron was determined as black oxide $\dot{F}\dddot{\bar{F}}$; the iron was assumed to be in the state of red oxide in *d*, and in the state of protoxide in *e*.

Is found in crystals imbedded in calcite on Mount Monzoni near Vigo in Fassathal. Crystals having the same form and composition have been found by Dr. Percy in the slags of an iron furnace.

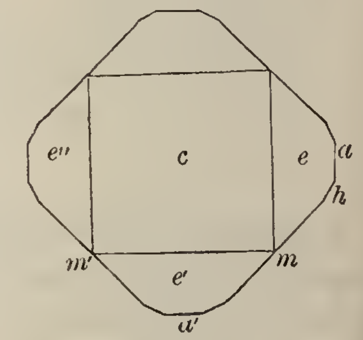
217. SOMERVILLITE.—Melilite, Humboldtilite, Somervillite; Phillips. Humboldtilite; Beudant. Humboldtilith Melilith; Mohs. Humboldtilit; Hausmann, Haidinger.

Pyramidal. 101,001 = 32° 51′.

c 001, *a* 100, *e* 101, *m* 110, *h* 210.

ec	32°	51′
ac	90	0
ha	26	34
ma	45	0
aa′	90	0
mm′	90	0

FIG. 395.



Combinations. *ca*, *cma*, *cah*, *cea*, *cmah*, *cemah*. Cleavage. *c*, perfect; *a*, traces. No cleavage has been observed in the variety called melilite. Fracture conchoidal...uneven. Semi-transparent...opaque. Lustre vitreous, on the surfaces of fracture inclining to resinous. White, green, yellow, brown. Streak white. H = 5·0...5·5. G = 2·90...3·104.

Melts without difficulty before the blowpipe. Gelatinizes with hydrochloric acid.

$2\dot{R}^3\ddot{Si}^2 + \dddot{\text{R}}\ddot{Si}$, where $\dot{R}$ is $\dot{C}a$, $\dot{M}g$, $\dot{N}a$, $\dot{K}$, and $\dddot{\text{R}}$ is $\dddot{A}l$ and $\dddot{\text{F}}e$.

Analyses *a*, *b* of melilite, G = 2·95, from Capo di Bove, *c* of humboldtilite, G = 2·90, from Monte Somma, all by Damour, *d* of humboldtilite from Vesuvius by v. Kobell:—

	a	*b*	*c*	*d*
Silica	39·27	38·34	40·60	43·96
Alumina	6·42	8·61	10·88	11·20
Red oxide of iron	10·17	10·02	4·43	$\dot{F}e$ 2·32
Lime	32·47	32·05	31·81	31·96
Magnesia	6·44	6·71	4·54	6·10
Soda	1·95	2·12	4·43	4·28
Potash	1·46	1·51	0·36	0·38

Is found in attached crystals, granular masses and disseminated, with calcite, on Monte Somma, and in the lava of Capo di Bove near Rome.

The want of cleavage in melilite renders its identity with somervillite rather doubtful. These minerals are united on the authority of MM. Damour and Descloizeaux.

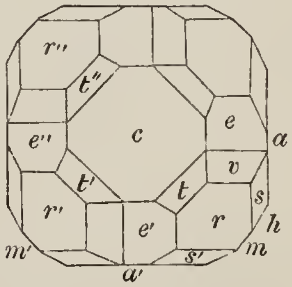
218. SARCOLITE.—Sarcolite; Phillips, Dufrénoy. Sarkolith; Mohs, Haidinger.

Pyramidal. 101,001 = 41° 35′.

a 100, *c* 001, *e* 101, *m* 110, *h* 210, *r* 111, *t* 113, *v* 313, *s* 311. The form *v* is hemihedral with parallel faces.

ha	26°	34′	*rc*	51°	27′
ma	45	0	*mc*	90	0
a′a	90	0	*sa*	26	40
mm′	90	0	*ra*	56	26
ec	41	35	*re*	33	34
ac	90	0	*ve*	12	28
tc	22	41	*rr′*	67	8

FIG. 396.



Combination. *acmehrtsv*. Fracture conchoidal. Semitransparent...translucent. Lustre vitreous. Flesh-red...white. Very brittle. H = 6·0. G = 2·545.

Fusible before the blowpipe.

Analysis by Scacchi :—

Silica	42·11
Alumina	24·50
Lime	32·43
Soda	2·93

Is found among the anciently ejected debris of Vesuvius.

219. SCAPOLITE.—Scapolite; Phillips. Meionite, Wernerite, Paranthine; Hauy. Pyramidaler Eläin-Spath. Mohs. Wernerit; Hausmann, Haidinger.

Pyramidal. 101,001 = 23° 45′·5.

c 001, *a* 100, *e* 101, *m* 110, *f* 310, *r* 111, *z* 311, *w* 331. The form *z* is sometimes hemihedral with asymmetric faces, the alternate faces *z* being wanting.

ac	90°	0′	*r′r″*	63°	48′	*wm*	28°	10′
aa′	90	0	*rr′*	43	53	*em*	73	27
ma	45	0	*wc*	61	50	*za*	39	37
fa	18	26						
fm	26	34						
e′e″	47	31						
ee′	33	7						
rc	31	54						
rm	58	6						

FIG. 397.

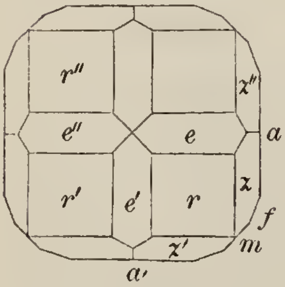
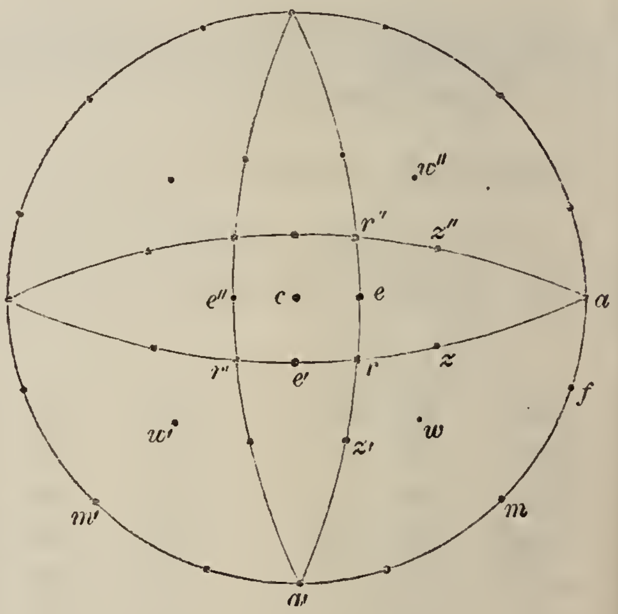


FIG. 398.



Combinations. *rma*, *crma*, *erma*, *rwzma*, *rzmaf*. Cleavage. *a*, perfect; *m*, imperfect; *c*, traces. Fracture conchoidal. Translucent...opaque. Lustre vitreous; on surfaces of fracture resinous; *a*, *m* pearly. Colourless, white, grey, green, red in impure varieties. Streak white...greyish-white. Brittle. H = 5·0...5·5. G = 2·61...2·78.

Before the blowpipe melts with intumescence into a translucent glass. With solution of cobalt becomes blue. Soluble with effervescence in borax and salt of phosphorus. In powder is decomposed by hydrochloric acid.

$\dot{\mathrm{C}}\mathrm{a}^3\ddot{\mathrm{S}}^2 + 2\dddot{\mathrm{A}}\mathrm{l}\ddot{\mathrm{S}}\mathrm{i}$, silica 39·77, alumina 33·11, lime 27·12, part of the lime being replaced by soda and potash. According to Harkort and Breithaupt scapolite always contains traces of fluorine.

Analyses of the transparent, colourless or light-coloured varieties (meionite) *a* from Monte Somma by L. Gmelin, *b* from Monte Somma by Stromeyer, *c* from Vesuvius by Wolff; of less transparent varieties (scapolite, ekebergite), *d* from Ersby in the parish of Pargas by Nordenskiöld, *e* from Pargas by Wolff, *f* from Pargas by Hartwall:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	43·80	40·53	42·07	43·83	45·10	49·42
Alumina	32·85	32·73	31·71	35·43	32·76	25·41
Lime	20·64	24·25	22·43	18·96	17·84	15·59
Soda	2·57	1·81	0·45	—	0·76	6·05
Potash	—		0·31	—	0·68	$\dot{\mathrm{M}}\mathrm{g}$ 0·68
Red oxide of iron .	1·07	0·18	—	—	—	1·40
Loss by ign. . . .	—	—	0·31	1·03	1·04	1·45

Analyses of scapolite *g* from Tunaberg by Walmstedt, *h*, *i* from Ersby, *k* from Petteby, all by Hartwall and Hedberg, *l* from Pargas by Nordenskiöld, *m* from Bolton (nuttallite) by Thomson:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	43·83	48·77	52·11	51·34	54·13	37·81
Alumina	35·28	31·05	27·60	32·27	29·23	25·10
Lime	19·37	15·94	13·53	9·33	15·46	18·34
Soda	—	3·25	3·86	5·12	$\dot{\mathrm{K}}$	7·31
Red oxide of iron .	0·61	—	0·55	1·91	$\grave{\mathrm{F}}\mathrm{e}$	7·89
Water	—	0·61	0·73	1·00	1·07	1·50

Analyses of scapolite *n* from Malsjö near Carlstadt in Wermland, massive, G = 2·623, *o* from Hirvesalo in Finland, in crystals and massive, G = 2·733, *p* from Bolton in Massachusetts, crystalline, G = 2·718, *q* from Hesselkulla, massive, G = 2·735, *r* from Arendal in crystals, G = 2·712, all by Wolff, *s* from Bocksäters in the parish of Drothem in Eastgothland, G = 2·34, by Berg:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	49·88	48·15	48·79	49·26	50·91	46·35
Alumina	27·02	25·38	28·16	26·40	25·81	26·34
Red oxide of iron .	0·21	1·48	0·32	0·54	0·75	0·32
Lime	12·71	16·63	15·02	14·44	13·34	17·00
Magnesia	0·85	0·84	1·29	—	0·58	0·54
Soda	7·59	4·91	4·52	6·14	7·09	4·71
Potash	0·87	0·12	0·54	0·65	0·85	0·32
Volatile	0·77	0·85	0·74	0·69	0·41	1·60
Undecomposed . .	—	—	—	—	—	0·99

Analyses of nuttallite (H = 4·0...4·5) *t* from Bolton in Massachusetts by Stadtmüller, of metamorphosed scapolite *u* from Ersby by Nordenskiöld, *v* from Bolton in Massachusetts by Thomson, *w* from Sjösa in Sweden, red (H = 6·0, G = 2·643), very difficult to fuse before the blowpipe, not decomposed by hydrochloric acid, by Berzelius, *x* from Pargas in slender grey crystals, not cleavable (H = 6·0 or more, G = 2·65), infusible and not decomposed by acids, by Wolff:—

	t	*u*	*v*	*w*	*x*
Silica	45·79	41·25	46·30	61·50	92·71
Alumina . . .	30·11	33·58	26·48	25·35	—
Lime	17·41	20·36	18·62	3·00	—
Magnesia . .	—	—	—	0·75	—
Red ox. iron .	1·86	—	—	1·50	7·29
Potash . . .	3·49	Ṁg, Ṁn 0·54,	Ṅa, L̇i 3·64,	Ṅa, K̇ 5·00	—
Water . . .	1·63	3·32	5·04	Ṁn 1·50	—

The analyses of varieties of meionite vary greatly, partly in consequence of the decomposition of the mineral, to which it is very liable, and partly on account of a mechanical admixture of quartz or mica.

In attached and imbedded crystals, and massive.

The transparent variety (meionite) is found near Vesuvius in cavities in granular limestone in the debris of ancient eruptions. The opaque varieties are found in the iron mines of Arendal in Norway; Malsjö, Hällestad, Hesselkulla in Sweden; at Pargas in Finland; at Eisenberg, Strasko and Ebersdorf in Moravia; at Akudlek in Greenland; at Barèges in France; at Bolton, Warwick and many other places in North America.

The minerals usually arranged under scapolite differ considerably in hardness. On this account the softer varieties have been regarded by Mr. Brooke as a distinct mineral, and named nuttallite. Specimens from Arendal, some from Finland, and one, according to its ticket, from Jefferson County, New

York, in separate crystals imbedded in calcite, are hard, and scratch with ease those from Littleton and Bolton, Massachusetts, and from Hinvenjalo in Finland. If the relative hardness of these minerals does not constitute a specific difference, it must be ascribed to an altered state of the crystals.

220. WICHTISITE.—Wichtisit; Hausmann. Wichtyn; Haidinger.

Cleavage in two directions nearly at right angles to each other. Fracture imperfect conchoidal. Dull. Black. G = 3·03. Magnetic.

Analysis by Laurent:—

Silica	56·3
Alumina	13·3
Red oxide of iron	4·0
Protoxide of iron	13·0
Lime	6·0
Magnesia	3·0
Soda	3·5

Is found at Wichtis in Finland.

221. GLAUCOPHANE.—Glaucophan; Hausmann.

Cleavage in two directions, not making right angles with each other. Fracture conchoidal. Translucent...nearly opaque. Lustre vitreous, inclining to pearly on cleavage faces; vitreous on the surfaces of fracture. Blueish-grey. Streak the same. H = 5·5. G = 3·103...3·113. In powder attractable by the magnet.

Before the blowpipe turns brown, and melts readily into an olive-green glass. With borax fuses with ebullition into a clear glass, showing the colour of iron while hot. Slowly and imperfectly decomposed by acids.

Analysis by Schnedermann:—

Silica	56·49
Alumina	12·23
Protoxide of iron	10·91
Protoxide of manganese	0·50
Magnesia	7·97
Lime	2·25
Soda with traces of potash	9·28

Is found in long slender crystals, and in columnar or granular masses, in a bed of mica slate in the island of Syra.

222. TALC.—Talc; Hauy. Prismatischer Talk-Glimmer; Mohs. Talk; Hausmann, Haidinger.

In thin six-sided plates, with angles of nearly 60°, having one very distinct cleavage.

The compact varieties have a splintery or earthy fracture. More or less translucent. Lustre pearly on the cleavages. The optic axes lie in a plane perpendicular to the cleavage, and make angles of 3° 42′ with a normal to the cleavage. By transmitted light, various shades of blue, green, grey; by reflected light, frequently silver-white. Streak white. In thin leaves flexible, but not elastic. Sectile. H = 1·0...1·5. G = 2·6...2·8. Unctuous to the touch.

Either infusible or fusible with great difficulty before the blowpipe. With solution of cobalt assumes a pale red colour. Not acted upon by acids.

Analyses of cleavable talc *a* from the little St. Bernard by Berthier, *b* from the Greiner, *c* from Brussiansk near Katharinenburg, both by v. Kobell, *d* from the Zillerthal, *e* from Rhode Island, both by Delesse, *f*, *g* from Chamouni by Marignac:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Silica	58·2	62·8	62·80	63·0	61·75	62·58	62·41
Magnesia . . .	33·2	32·4	31·92	33·6	31·68	35·40	35·49
Protox. iron . .	4·6	1·6	1·10	trace	1·70	1·98	2·06
Alumina . . .	—	1·0	0·60	—	—	—	—
Water	3·5	2·3	1·92	3·4	3·83	0·04	0·04

Analyses of greenish-white talc *h* from Roschkina in the district of Slatoust by Hermann, of massive varieties (speckstein) *i* from Mont Caunegou, *k* from Sahla, *l* from Scotland, *m* from China, *n* from Wunsiedel, all by Lychnell, *o* from Voigtsberg (G = 2·795) by Kersten:—

	h	*i*	*k*	*l*	*m*	*n*	*o*
Silica . . .	59·21	66·70	63·13	64·53	66·53	65·64	66·02
Magnesia . .	34·42	30·23	34·30	27·70	33·42	30·80	31·94
Protox. iron .	2·14	2·41	2·27	6·85	trace	3·61	0·81
Ox. nickel . .	0·12	—	—	—	—	$\dot{\mathrm{N}}\mathrm{a}$, $\dot{\mathrm{K}}$	0 75
Water . . .	1·00	—	—	—	—	—	0·20
Carb. ac. . .	2·50	—	—	—	—	—	—

In crystals; slaty or earthy masses; pseudomorphous after kyanite, felspar, pyrope, quartz, andalusite, augite, tourmaline, topaz, dolomite.

It occurs alone as talk-slate, and with quartz, mica, chlorite, felspar, forms various slaty and granular rocks; in beds with kyanite and staurolite; in beds of magnetite, towanite and galena; in veins of tin ore. Crystallized talc is found on the Greiner in the Zillerthal in the Tyrol, St. Gotthard, the district of Salzburg, Stiria, Sahla, Fahlun and other places in Sweden, Bodenmais in Bavaria, Katharinenburg in Siberia, in many parts of Scotland. The massive variety is found at Göpfersgrün near Wunsiedel in the Fichtelgebirge, pseudomorphous after various minerals, in the tin mines of Saxony and Bohemia, the United States, Greenland.

223. BIOTITE.—Mica (in part); Hauy. Rhomboedrischer Talk-Glimmer; Mohs. Biotit; Hausmann. Meroxen; Haidinger.

Rhombohedral. 100,111 = 70° 0′.

o 111, *a* $01\bar{1}$, *r* 100, *s* $\bar{1}11$, *w* $14\bar{2}$, *v* $15\bar{3}$, *z* $17\bar{5}$.

ao	90°	0′	*rr′*	108°	56′	*wo*	78°	8′
aa′	60	0	*so*	79	41	*vo*	81	3
ro	70	0	*ss′*	116	52	*zo*	84	0

FIG. 399.

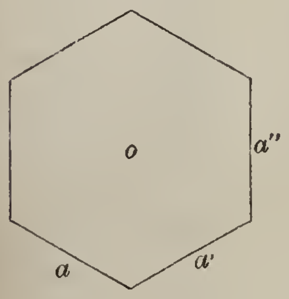


FIG. 400.

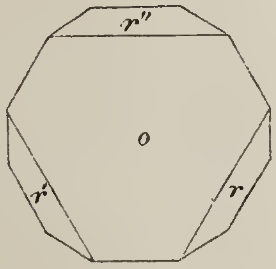
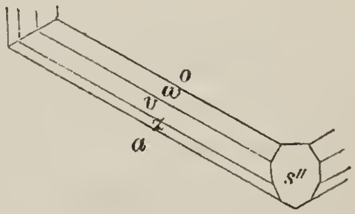


FIG. 401.



Combinations. *oa*, *or*, *oaswvz*. Cleavage. *o*, very perfect. Transparent...translucent; less so in a direction perpendicular to *o* than parallel to *o*. Lustre, *o* pearly inclining to metallic; the other faces vitreous. Dark green, brown, passing into black. Streak white...pale greenish-grey. Sectile. In thin leaves elastic. H = 2·0...2·5. *o* less hard than the other faces. G = 2·78...2·95.

In the matrass yields water and, usually, traces of hydrofluoric acid. Before the blowpipe melts with difficulty into a grey or black bead. Soluble in borax forming a glass coloured by iron. Is slightly attacked by hydrochloric acid. Is completely decomposed by sulphuric acid, leaving pearly scales of silica.

$\dot{R}^3\ddot{Si}^2 + \dddot{Al}\ddot{Si}$, where $\dot{R}$ denotes $\dot{Mg}$, $\dot{K}$, $\dot{Fe}$, and part of the $\dddot{Al}$ is replaced by $\overline{Fe}$.

Analyses of biotite *a* from Miask, *b* from Monroe, *c* from Karosulik, *d* from Bodenmais, all by v. Kobell, *e* from Pargas by Svanberg, *f* from the Baikal by H. Rose :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	42·12	40·00	41·00	40·86	42·59	42·01
Alumina	12·83	16·16	16·88	15·13	21·68	16·05
Red oxide of iron . .	10·38	7·50	4·50	13·00	10·39	4·93
Magnesia	16·15	21·54	18·86	22·00	10·27	25·97
Protoxide of iron . .	9·36	—	5·05	(lime	0·26	—)
Potash	8·58	10·83	8·76	8·83	8·45	7·55
Protox. man. . . .	—	—	—	—	0·75	—
Hydrofl. ac. . . .	—	0·53	—	(F	0·51)	0·68
Tit. acid	—	0·20	—	Ca	0·56	—
Water	1·07	3·00	4·30	0·44	3·35	—

Of the following varieties of mica, having nearly the same chemical constitution as biotite, the forms and optical properties are unknown. Mica *g* from Sahla and *h* from Rosendal near Stockholm by Svanberg, *i* from Vesuvius by Bromeis, *k* from the Zillerthal by Varrentrapp, *l* from Miask by H. Rose :—

	g	*h*	*i*	*k*	*l*
Silica	42·65	44·41	39·79	39·85	40·00
Alumina	12·86	16·86	16·01	16·07	12·67
Aluminium	0·10	$\ddot{\cancel{\mathrm{Fe}}}$	8·30	13·21	19·03
Magnesia	25·39	11·26	24·51	15·60	15·70
Magnesium	0·36	—	—	—	—
Protoxide of iron . .	7·11	20·71	—	$\ddot{\mathrm{Ti}}$	1·63
Protox. mangan. . .	1·06	0·46	—	—	0·63
Lime	—	0·90	0·87	0·42	—
Calcium	—	0·43	—	—	—
Potash	6·03	4·05	8·79	13·68	5·61
Fluorine	0·62	0·41	0·51	FH	2·10
Water	3·17	1·13	0·75	—	—

In *k* potash 13·68 includes soda and loss.

In imbedded and attached crystals, usually very thin in a direction perpendicular to *o*; in scaly and granular aggregations. Is much less widely diffused than the biaxal mica.

Is found in the miascite, and in the veins of granite which traverse it, in the Ilmen mountains, in several parts of the Ural in chlorite slate, in large crystalline plates with malacolite on the Baikal, at Monroe in New Jersey, Karosulik in Greenland, in the older masses ejected by Vesuvius. The combination *oaswvz* was observed by Marignac in mica from Vesuvius.

Some varieties of mica exhibit two optic axes, making with each other a very small angle. Possibly these may have been uniaxal in their normal condition, and the separation of the single optic axis into two may be due to the state of strain produced in the crystal in the process of detaching and cleaving it.

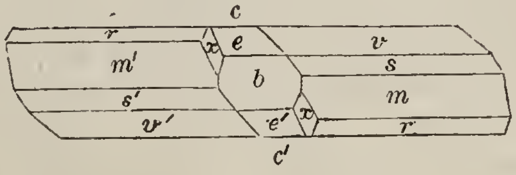
224. MICA.—Mica (in part); Phillips, Hauy. Hemiprismatischer Talk-Glimmer; Mohs. Glimmer; Hausmann, Haidinger.

Oblique. 101,100 = 25° 19′; 111,010 = 64° 46′; 101,001 = 54° 42′.

b 010, *c* 001, *e* 021, *m* 110, *s* 111, *r* 11$\bar{1}$, *v* 112, *x* 13$\bar{1}$.

bc	90°	0′	*mc*	81°	20′	*sbc*	54°	42′
mb	60	23	*rc*	107	5	*mbc*	80	1
sb	64	46	*mm′*	120	46	*rbc*	109	34
rb	61	27						
vb	70	4						
eb	24	45						
xb	31	30						
vc	43	1						
sc	58	32						

FIG. 402.



Combinations. *cmb*, *cmbvsrex*. Cleavage. *c*, very perfect; *m*, *b* traces. Fracture conchoidal, seldom observable. Transparent...in thin leaves translucent. Lustre, *c* pearly inclining to metallic; the other faces vitreous inclining to adamantine. R = 1·500. The optic axes lie in a plane perpendicular to *c*. The angle between either axis and a normal to *c* varies in different varieties from 3° to 22° 31′. Colourless, white, various shades of grey, brown, green, black. Colours by reflected and transmitted light frequently different. Streak white...grey. Sectile; in thin leaves elastic. H = 2·5. G = 2·8...3·1.

In the matrass yields water and a trace of hydrofluoric acid. Before the blowpipe melts into a yellowish-grey blebby glass. Different varieties possess very different degrees of fusibility; those containing fluorine become dull when heated. Is dissolved readily in borax and in salt of phosphorus, leaving a skeleton of silica in the latter. Is not decomposed by hydrochloric or sulphuric acid, the chrome-mica from the Zillerthal excepted, which is acted upon by hydrochloric acid.

Analyses of mica *a* from Utö, *b* from Broddbo, *c* from the neighbourhood of Fahlun, *d* from Kimito, *e* from Ochotzk, all by H. Rose, *f* brown mica from Cornwall by Turner:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	47·50	46·10	46·22	46·36	47·19	36·54
Alumina	37·20	31·60	34·52	36·80	33·80	25·47
Red ox. iron	3·20	8·65	6·04	4·53	4·47	27·06
Oxide of mangan.	0·90	1·40	2·11	—	2·58	1·92
Lime	—	—	—	—	0·13	0·93
Potash	9·60	8·39	8·22	9·22	8·35	5·47
Water	2·63	1·00	0·98	1·84	4·07	—
Hydrofluoric acid	0·56	1·12	1·09	0·71	0·29	2·70

Analyses of mica *g* from Broddbo, *h* from Abborforss, both by Svanberg, *i* from Jefferson County in New York by Meitzendorff, *k* from Siberia by Klaproth, *l* green mica from Schwarzenstein in the Zillerthal (fuchsite), *m* chrome-mica from Schwarzenstein, both by Schafhäutl:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	47·97	39·45	41·30	48·00	47·95	47·68
Alumina	31·69	9·27	15·35	34·25	34·45	15·15
Red ox. iron	5·37	35·78	1·77	4·50	1·80	5·72
Oxide of mangan.	1·67	(Ṁn 2·57)	—	0·50	—	1·17
Protox. iron	—	1·45	ox. chrome		3·95	5·91
Magnesia	—	3·29	28·79	—	0·72	11·58
Lime	—	0·31	—	(soda	0·37	1·17)
Potash	8·31	5·06	9·70	8·75	10·75	7·27
Water	3·32	—	0·28	1·25	—	2·86
Fluorine	0·72	0·29	3·30	—	0·35	—
Aluminium	0·35	Ṅa,L̇i	0·65	—	—	—
Calcium	—	0·32	—	—	0·42	—

Analyses of mica *n*, silver-white, locality unknown, G = 2·831, by Rammelsberg, *o* from Zsidovácz, G = 2·817, by Kussin, *p* from Vesuvius in oblique crystals, blackish-green, by Chodnew, *q* from the Zillerthal by Varrentrapp, *r* from St. Etienne (G = 2·817) by Delesse, *s* of six-sided prismatic crystals, resembling mica, formed in the slags of a copper furnace at Garpenberg, by Mitscherlich:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	47·84	48·07	40·91	39·85	46·23	47·31
Alumina	32·36	38·41	17·79	16·07	33·03	5·74
Red ox. iron	3·06	—	11·02	13·21	3·48	28·91
Ox. mang.	—	—	—	—	trace	0·48
Magnesia	1·28	—	19·04	15·60	2·10	10·17
Lime	0·29	—	0·30	0·42	—	6·23

	n	*o*	*p*	*q*	*r*	*s*
Potash	10·25	10·10	9·96	13·68 Ḣ,FH	8·87	1·05
Soda	1·55	—	—		1·45	—
Water	2·43	3·42	—		4·12	—

In *p* part of the iron is supposed to be in the state of protoxide. This analysis appears to show that the substance of biotite, with which it agrees very nearly, is dimorphous.

Mica is an essential ingredient of granite, gneiss, mica-slate, and is often found in fissures in those rocks, or crystallized in the cavities of the veins which traverse them. It also occurs in sand stones and various slate rocks, to which it imparts the property of cleavage; in veins and cavities in porphyry, basalt, dolomite, limestone, lava, and in matter ejected from volcanoes; investing or imbedded in andalusite, pinite, scapolite, tourmaline and other minerals.

Is found on Vesuvius, the Ilmen mountains, at Alabaschka near Mursinsk, the Adun-Tschilon mountains near Nertschinsk, and in very large transparent plates on the upper part of the course of the Witim in Siberia, at Pargas in Finland, Narkseilsiak in Greenland, in various parts of the United States, at Rio Janeiro, in large plates near Skutterud in Norway, in curved laminæ at Skogböle in Kimito in Finland. Mica occurs occasionally in the slags of furnaces. The clay sandstone forming the wall of iron furnaces has been found converted into a substance like mica. Some varieties of mica suffer decomposition, and are converted into a steatitic substance.

The figure and angles given above are deduced from the measurements of a crystal from Vesuvius by W. Phillips. The crystal from the valley of Binnen, described by Marignac (Bibl. Univ. de Geneve. Ser. 4. T. 6. Supp. p. 301), is perhaps a combination of the forms *cbmuz*, where *u* is $22\bar{1}$ and *z* is $26\bar{1}$. *u* truncates the edge *mr*, and *z* is common to the zones *bu*, *xc*. $uc = 94° 26'$, $ub = 60° 6'$, $zb = 30° 6'$.

225. LEPIDOLITE.—Lepidolite; Phillips. Mica (in part); Hauy. Hemiprismatischer Talk-Glimmer (in part); Mohs. Lepidolith; Hausmann, Haidinger.

Oblique?

b 010, *c* 001, *m* 110.

mb	59°	30′
mm′	61	0

Combination. *cbm*. Cleavage. *c*, very perfect; *m*, *b* traces.

Fracture conchoidal, seldom observable. Transparent...translucent on the edges. Lustre, on *c* pearly inclining to adamantine; on the other faces vitreous. Of various shades of white, grey, green, rose-red, peach-blossom-red, violet; frequently silver-white by reflected right, rose-red by transmitted light. Streak white. In thin leaves elastic. H = 2·0...3·0. G = 2·8...3·0.

Before the blowpipe melts into a white or grey glass, sometimes into a black magnetic bead. Imparts a purple colour to the flame. Is acted upon more or less by acids. The variety from Altenberg is completely decomposed by sulphuric acid.

Analyses of lepidolite *a* from Rozena by C. Gmelin, *b* from Rozena by Kralowansky, *c* from Chursdorf by C. Gmelin, *d* from Zinnwald by C. Gmelin, *e* from Cornwall, brown, by Turner, *f*, locality unknown, yellow, by Regnault:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	49·06	49·08	52·25	46·23	40·06	49·78
Alumina	33·61	34·01	28·35	14·14	22·90	19·88
Red ox. iron . . .	—	—	—	17·97	27·06	13·22
Protox. mangan. . .	1·40	1·08	3·66	4·57	1·79	—
Magnesia	0·41	0·41	—	—	—	—
Potash	4·19	4·19	6·90	4·90	4·30	8·79
Lithia	3·59	3·58	4·79	4·21	2·00	4·15
Hydrofluoric acid .	3·45	3·50	5·07	8·53	2·71	4·25
Phosphoric acid . .	0·11		—	—	—	—
Water	4·18	4·15	trace	0·83	—	—

Analyses of lepidolite *g* from Zinnwald, *h* from Altenberg, *i* from Utö, *k* from the Ural, *l* from Cornwall, grey, all by Turner, *m* perhaps from Rozena by Regnault:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	44·28	40·19	50·91	50·35	50·82	52·40
Alumina	24·53	22·79	28·17	28·30	21·33	26·80
Protox. iron . . .	11·33	19·78	—	—	9·08	—
Protox. mangan. . .	1·66	2·02	1·08	1·23	trace	1·50
Potash	9·47	7·49	9·50	9·04	9·86	9·14
Lithia	4·09	3·06	5·67	5·49	4·05	4·85
Hydrofluoric acid .	5·14	3·99	4·11	5·20	4·81	4·40

Analyses of lepidolite *n*, *o* from Juschakowa near Mursinsk by Rosales, *p* from Altenberg by Stein, from Zinnwald *q* by Lohmeyer, *r* by Stein, *s* from Zinnwald, *t* of lepidolite (G = 2·848) associated with red decomposing tourmaline from Rozena in Moravia, both by Rammelsberg:—

	n	o	p	q	r	s	t
Silica . . .		48·92	47·01	42·97	48·65	46·52	51·70
Alumina . .	20·80	19·03	20·35	20·59	17·67	21·81	26·76
Red ox. iron .	—	—	14·34	14·18	—	4·78	—
Ox. man. . .	4·30	5·59	—	0·83	—	—	1·29
Protox. man. .	—	—	1·53	—	1·24	1·96	—
Lime . . .	0·11	0·14	—	$(\dot{\mathrm{Fe}}$	14·57	6·80)	0·40
Magnesia . .	—	—	—	—	0·53	0·44	0·24
Potash . . .	10·96		9·62	10·02	8·60	9·09	10·29
Lithia . . .	2·77		4·33	1·60	2·41	1·27	1·27
Soda . . .	2·23		—	1·41	0·71	0·39	1·15
Fluorine . .		10·44	1·43	6·35	8·16	7·47	7·12
Chlorine . .		1·31	0·40	0·21	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	0·13	0·16
Loss ign. . .	—	—	1·53	0·22	—	—	—

It occurs principally in granite, taking the place of mica, and in beds and veins in granite and gneiss.

Is found at Rozena near Hradisko in Moravia, at Chursdorf near Penig in Saxony, in Utö, near Mursinsk in the Ural, at Paris in Maine, Middletown in Connecticut, in the tin-mines of Bohemia, Saxony and Cornwall.

226. MARGARITE.—Margarite; Phillips, Beudant. Hemiprismatischer Perl-Glimmer; Mohs. Margarit; Hausmann, Haidinger.

Oblique.

In thin six-sided prisms forming thin crystalline laminæ. Cleavage parallel to the base of the prism, very perfect. Semi-transparent...translucent. Lustre, the cleavage faces pearly; the other faces vitreous. Reddish-white, greyish-white, pearl-grey. Streak white. Rather brittle. In thin leaves slightly elastic. H = 3·5...4·5. G = 3·0...3·1.

Intumesces and melts before the blowpipe. Is attacked by acids.

Analysis of margarite made in the Göttingen laboratory:—

Silica	33·50
Alumina	58·00
Lime	7·50
Protoxide of iron	0·42
Magnesia	0·05
Protoxide of manganese . . .	0·03

Is found at Sterzing in the Tyrol with chlorite.

227. LEPIDOMELANE.—Lepidomelane; Hausmann.

Crystallized in six-sided plates having a cleavage parallel to the base of the crystal. Fracture not observable. Opaque. Lustre vitreous, inclining to adamantine. Black, in extremely thin scales leek-green by transmitted light. Streak mountain-green. Rather brittle. H = 3·0. G = 3·0.

Before the blowpipe, in a strong heat, melts into a black, magnetic globule. Readily soluble in borax forming a green glass. Decomposed easily by hydrochloric acid, leaving a residue of silica in pearly scales.

$\overset{\cdots}{\mathrm{R}\!\!\!-}\ddot{\mathrm{Si}} + \dot{\mathrm{R}}\ddot{\mathrm{Si}}$.

Analysis by Soltmann:—

Silica	37·40
Alumina	11·60
Red oxide of iron	27·66
Protoxide of iron	12·43
Magnesia and lime	0·26
Potash	9·20
Water	0·60

Is said to have been found in six-sided tabular crystals, and scaly, crystalline masses, at Persberg in Wermland in Sweden.

228. SPHENE.—Sphene; Phillips. Titane calcaréo-silicieux; Hauy. Prismatisches Titan-Erz; Mohs. Sphen; Hausmann, Haidinger.

Oblique. 101,100 = 34° 27′; 111,010 = 68° 8′; 101,001 = 60° 27′.

b 010, *c* 001, *r* 011, *o* 013, *y* 101, *x* 102, *v* $\bar{1}01$, *l* 110, *m* 130, *s* 141, *u* 163, *n* 123, *z* 112, *e* 113, *w* 214, *t* $\bar{1}21$.

xc	39°	21′	*ll′*	133°	48′
yc	60	27	*ub*	39	34
vc	53	34	*nb*	68	2
oc	12	20	*eb*	78	36
rc	33	16	*uu′*	79	7
bc	90	0	*nn′*	136	4
mb	38	1	*sb*	33	52
mm′	76	1	*yb*	90	0
lb	66	54	*ss′*	67	44

wx	7°	44′
zx	15	11
tb	55	27
tv	34	33
zy	25	47
ny	38	24
ry	65	39
ty	109	35
ly	40	40
lc	94	30
mc	93	52
ur	28	4
sr	51	32
mr	75	46
tr	106	1
nbc	28	7
lbc	94	54

FIG. 403.

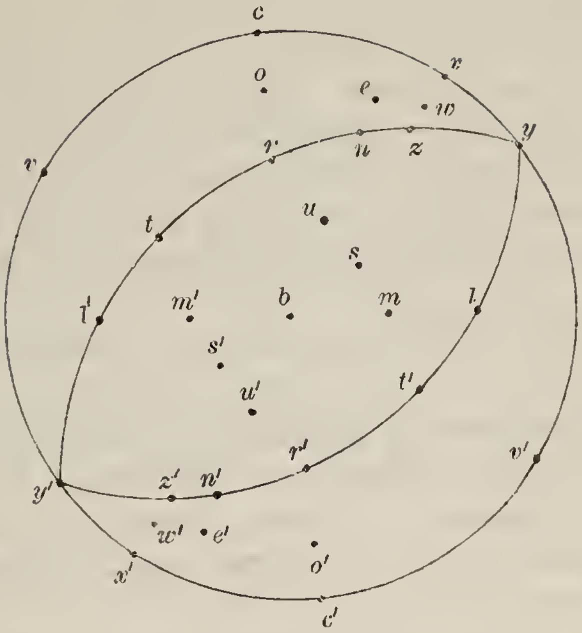


FIG. 404.

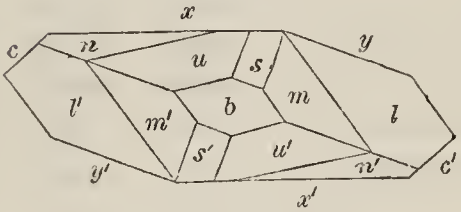


FIG. 405.

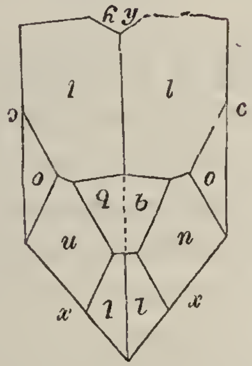
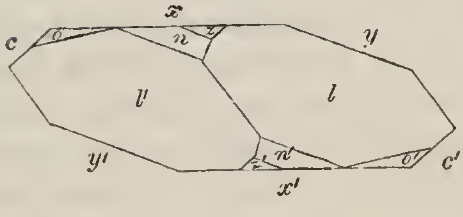


FIG. 406.



Combinations. *cyn..r.l.t.x*, *ryn*, *cyxl..n.s.t.m.r*, *cyxls*, *cyxlmb*, *tlmsn.cyx*. The faces *c*, *l* faintly striated parallel to their intersections with *r*; *s* striated parallel to their intersections with *t*, *n*, *s*; *x* frequently rounded, *y* sometimes rounded. Twins. 1. Twin-face *c*. 2. Twin-face *y*. Cleavage. *r*, sometimes distinct; *c*, *l* less distinct. Fracture, imperfect conchoidal. Transparent...translucent on the edges. Lustre adamantine, inclining to vitreous. For rays in a plane parallel to *b* and polarized in that plane $\mu = 1{\cdot}631$. The optic axes lie in a plane parallel to *b*, and make angles of about 15° 11′ with a normal to *x*. Yellow, green, brown, sometimes yellow passing into brown at one end, red. Exhibits pleochroism. Streak white; light red in greenovite. H = 5·0...5·5. G = 3·3...3·7. Pyroelectric.

Before the blowpipe melts on the edges with intumescence into a dark glass. With borax yields a transparent yellow glass. With salt of phosphorus and tin in the inner flame yields a violet glass. Is partially decomposed by hydrochloric acid; perfectly decomposed by sulphuric acid, or by fusion with six times its weight of bisulphate of potash.

$\dot{\mathrm{C}}\mathrm{a}^2\ddot{\mathrm{S}}\mathrm{i} + \ddot{\mathrm{T}}\mathrm{i}^2\ddot{\mathrm{S}}\mathrm{i}$, silica 31·13, titanic acid 40·56, lime 28·31.

Analyses of sphene, *a* from Schwarzenstein in the Zillerthal by Fuchs, *b* from the Zillerthal by H. Rose, *c* from Arendal by Rosales, *d* from Passau by Brooks, of a red variety (greenovite), *e*, *f* from Saint Marcel by Delesse, *g* by Marignac:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Silica	32·52	32·29	31·20	30·63	30·4	29·8	32·26
Titanic acid . .	43·21	41·58	40·92	42·56	42·0	43·0	38·57
Lime	24·18	26·61	22·25	25·00	24·3	23·6	27·65
Protox. iron . .	—	0·96	5·06	3·93	—	—	0·76
Protox. mang. .	—	—	—	—	3·6	2·9	0·76

In imbedded and attached crystals, massive; in granite, syenite, gneiss, crystalline slate rocks, marble, trachyte, basalt, basaltic lava, in rocks ejected by volcanoes.

Is found crystallized in Dauphiné, Montblanc, St. Gotthardt, Dissentis in the Grisons, Val Maggia and St. Marcel (greenovite) in Piedmont, Pfunders and Pfitschthal in the Tyrol, Salzburg, near Barèges in the Pyrenees, Achmatowsk near Slatoust in the Ural. Crystallized and massive in Norway at Arendal in beds of iron ore, and near Laurvig and Friedrichswärn, in Sweden at Trollhätta, Taberg, Borkut, Söderfors, Gustavsberg; in small quantities in syenite near Dresden and Meissen, Moravia, Weinhem on the Bergstrasse; in granite and gneiss near Aschaffenburg, Passau, Windisch-Kappel in Carinthia; at Aussig and Töplitz in Bohemia in phonolite; in basalt at Wessel in Bohemia; on the lake of Laach in glassy felspar; near Nantes and the Puy de Dome in France, the Kaiserstuhl in the Breisgau, Vesuvius, the Sau Alp; in Scotland in the Criffle and other hills in Galloway, on the south side of Loch Ness, near the King's House, Ben Nevis, Aberdeenshire, Mid Lothian, Loch Triesta in Feltar, one of the Shetlands; in gneiss at Altaness in the island of Burray; in Ireland in Carriglinneen in mica slate; Sarlut in Greenland, the Brazils, the United States, the Greek islands.

229. SCHORLOMITE.—Ferrotitanite; Whitney (Journal of the Boston Nat. Hist. Soc., Jan. 1849, p. 42), Schorlamit; Rammelsberg.

Amorphous. Fracture conchoidal. Opaque. Lustre vitreous. Black, iridescent. H = 7·5. G = 3·783...3·807.

Before the blowpipe melts on the edges with difficulty into a black mass. With borax in the outer flame forms a yellow bead which becomes colourless on cooling; in the inner flame with the addition of tin yields a green bead. With salt of phosphorus on charcoal in the inner flame with tin forms a violet bead. Partially decomposed by hydrochloric acid forming a yellow solution, which on the addition of ammonia yields a yellow precipitate.

$2\dot{R}\ddot{Si} + \dot{R}^2\ddot{Ti}$, where $\dot{R}$ is $\dot{Fe}$, $\dot{Ca}$, $\dot{Mg}$.

Analyses *a*, *b* by Whitney, *c*, *d* by Rammelsberg, *e*, *f* by Crossley:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	27·89	25·66	27·85	26·09	25·66	26·36
Titanic acid . . .	20·43	22·10	15·32	17·36	22·10	21·56
Red ox. iron . . .	21·90	21·58	—	—	21·58	22·00
Protox. iron . . .	—	—	23·75	22·83	—	—
Lime	30·05	29·78	32·01	31·12	29·78	30·72
Magnesia	—	—	1·52	1·55	—	1·25

In analyses *a*, *c* the silica contained some titanic acid. In *a*, *b* the oxide of iron contained a little manganese.

Occurs massive with brookite at Magnet Cove, Hot Springs county, Arkansas. This mineral differs much in external characters and in chemical composition from the mineral described by Prof. Shepard as schorlomite.

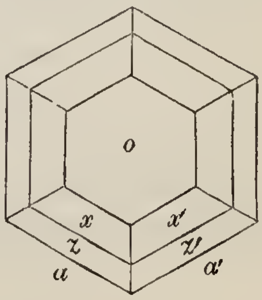
230. PYROSMALITE.—Pyrosmalite; Phillips, Dufrénoy. Axotomer Perl-Glimmer; Mohs. Pyrosmalith; Hausmann, Haidinger.

Rhombohedral. 100,111 = 46° 42′.

o 111, *a* 01$\bar{1}$, *x* 120, *z* 13$\bar{1}$.

ao	90°	0′
aa′	60	0
xo	31	30
zo	50	47
xx′	30	17
zz′	45	35

FIG. 407.



Combinations. *oa*, *oax*, *oaxz*. Cleavage. *o*, perfect; *a* less perfect. Fracture uneven. Translucent...opaque. Lustre, pearly on *o*, on the other faces resinous. Liver-brown...olive-green. Streak lighter than the colour. Rather brittle. H = 4·0...4·5. G = 3·0...3·2.

In the matrass yields yellow drops of chloride of iron, the decomposed varieties give off water. Before the blowpipe melts into a black magnetic globule. With borax and salt of phosphorus yields the reactions of iron, manganese and silica; with salt of phosphorus and oxide of copper the reaction of chlorine. Is completely decomposed by hydrochloric acid and concentrated nitric acid.

Analyses by Hisinger:—

Silica	35·40	35·85
Red oxide of iron	32·60	35·48
Peroxide of manganese	23·10	23·44
Lime	—	1·21
Alumina	0·60	—
Hydrochloric acid	6·50	2·91
Water		—

It is supposed that the iron and manganese in the silicates must have been in the state of protoxides.

In attached and imbedded crystals.

The undecomposed varieties are found at Nya Kopparberg in Westmannland, the decomposed varieties at Bjelke Gruvan near Philipstad in Wermeland in Sweden.

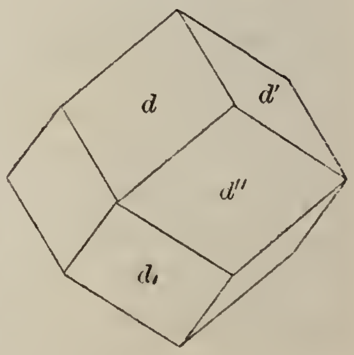
231. SODALITE.—Sodalite; Phillips, Hauy. Dodekaedrischer Amphigen-Spath (in part); Mohs. Sodalith; Hausmann, Haidinger.

Cubic.

a 100, *d* 011, *n* 211.

aa′	90°	0′
da′	45	0
dd′	60	0
dd,	90	0
na	35	16
nd	54	44

FIG. 408.



Combinations. *ad*, *adn*. Cleavage, *d*. Fracture conchoidal, uneven. Semi-transparent…translucent. Lustre vitreous, on the surface of fracture inclining to resinous. Colourless, white inclining to yellow, green, grey, blue. Streak white. H = 6·0. G = 2·287 …2·292.

Before the blowpipe melts with more or less difficulty into a colourless glass. Is completely decomposed by hydrochloric acid and nitric acid forming a jelly of silica.

$NaCl + 3\dot{Na}\ddot{Si} + 3\dddot{Al}\ddot{Si}$, silica 37·6, alumina 31·4, soda 19·1, sodium 4·7, chlorine 7·2.

Analyses of sodalite *a* from Greenland by Ekeberg, *b* from Vesuvius by Arfvedson, *c* from the Ilmen mountains by E. Hoffmann, blue sodalite *d*, *e* from Lichfield in the State of Maine by Whitney, *f* from Lamö by Borck :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	36·00	33·75	38·40	37·30	37·63	38·86
Alumina	32·00	35·50	32·04	32·88	30·93	30·82
Red oxide of iron	0·15	—	—		1·08	—
Magnesia	—	—	—	—	—	0·44
Soda	25·00	26·23	24·47	23·86	25·48	22·03
Potash	—	—	—	0·59	—	0·51
Lime	—	—	0·32	—	—	1·21
Chlorine	6·75	5·30	7·30	6·97	—	undet.

In crystals, rounded grains, and granular masses.

White sodalite is found in the older masses ejected by Vesuvius, and in the modern lavas, in drusy cavities at Palagonia in the Val di Noto in Sicily, a green variety massive and crystallized, with eudialyte, arfvedsonite, felspar, in a bed in mica slate, at Kangerdluarsuk in Greenland, a blue variety (the first cancrinite) with felspar and elæolite in the Ilmen mountains in Siberia. Sodalite is also found in trachyte at Rüden near Laach, in syenite at Friedrichswärn in Norway, Lichfield in the State of Maine.

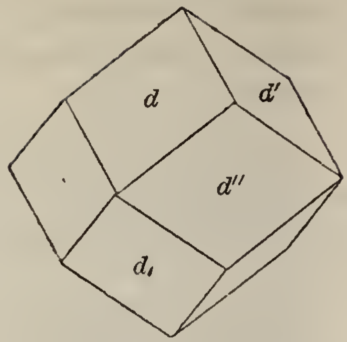
232. HAUYNE. — Hauyne; Phillips, Hauy. Dodekaedrischer Amphigen-Spath (in part); Mohs. Hauyn; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011.

aa′	90°	0′
oo′	70	32
oa	54	44
dd′	60	0
$dd_{,}$	90	0
da′	45	0
do	35	16

FIG. 409.



Combinations. *da*, *dao*. Cleavage. *d* more or less perfect. Fracture conchoidal...uneven. Transparent...opaque. Lustre vitreous. Black, brown, grey, blue of various shades. Streak of the deep blue varieties, light blue. H = 5·5...6·0. G = 2·25...2·50.

Before the blowpipe loses its colour and melts into a white blebby glass. Is decomposed by hydrochloric acid leaving a jelly of silica. The blue varieties (hauyne and lapis lazuli) lose their colour in hydrochloric acid and yield hydrosulphuric acid gas. Water dissolves sulphate of lime out of lapis lazuli.

Analyses of the brown and grey varieties, G = 2·25...2·28 (nosean), from the lake of Laach *a*, *b* by Bergmann, *c*, *d* by Whitney, *e* by Varrentrapp:—

	a	*b*	*c*	*d*	*e*
Silica	38·50	37·00	36·52	36·53	35·99
Alumina	29·25	27·50	29·54	29·42	32·57
Red ox. iron . . . (Ḟe	1·50	1·15)	0·44	0·44	—
Oxide mangan.	1·00	0·50	—	Fe	0·04
Lime	1·14	8·14	1·09	1·62	1·11
Soda	16·56	12·24	23·12	22·97	17·84
Sulphuric acid	8·16	11·56	7·66	7·13	9·17
Hydrosulphuric acid . .	3·00	1·50	—	—	—
Chlorine	—	—	0·61	0·61	0·65
Water	—	—	1·37	1·37	1·85

Analyses of the light blue or green varieties, G = 2·40...2·50 (hauyne), *f* from Marino by L. Gmelin, from Niedermendig *g*, *h* by Whitney, *i* by Varrentrapp, from Albano *k* by Whitney, of the deep blue variety, G = 2·38...2·42, (lapis lazuli) *l* by Varrentrapp:—

	f	*g*	*h*	*i*	*k*	*l*
Silica	35·48	34·83	33·90	35·01	32·44	45·50
Alumina	18·87	28·51	28·07	27·42	27·75	31·76
Red ox. iron . .	1·16	0·31	(S	0·24	—	0·95)

	f	*g*	*h*	*i*	*k*	*l*
Lime	12·00	7·23	7·50	12·55	9·96	3·52
Soda	—	18·57	19·28	9·12	14·24	9·09
Potash	15·45	—	—	—	2·40	—
Sulphuric acid .	12·39	12·13	12·01	12·60	12·98	5·89
Hydros. ac. & loss	3·45	—	water	0·62	—	0·12
Iron	—	—	—	0·17	—	0·86
Chlorine . . .	—	—	—	0·58	—	0·42

In crystals, crystalline grains, massive and disseminated.

The brown and grey variety (nosean) is found in volcanic rocks around the lake of Laach in Rhenish Prussia, and at Rüden near Laach. The light blue or green variety (hauyne) is found in isolated blocks consisting chiefly of rhyacolite, around the lake of Laach, in vesicular basalt at Niedermendig near Andernach on the Rhine, in phonolite on Mont d'Or in France, in peperino at Marino and Albano near Rome, in lava near Capo di Bove, around Vesuvius in ejected rocks, in the lava of the Vultur mountain near Melfi. The deep blue variety (lapis lazuli) occurs mixed with calcite, mica and pyrite on the Sljudenka not far from the Baikal lake, in the provinces of Kiang-si and Canton in China, Thibet, Badakschan in Tartary.

233. ITTNERITE.—Ittnerite; Phillips. Ittnérite; Beudant. Dodekaedrisches Amphigen-Spath (in part); Mohs. Ittnerit; Hausmann. Haüyn (in part); Haidinger.

Cubic.

d 011.

dd'	60° 0'	(fig. 409.)
$dd_{,}$	90 0	

Cleavage. *d* distinct. Fracture, flat conchoidal...uneven. Translucent on the edges. Lustre resinous inclining to vitreous. Dark blueish-grey, smoke-grey, ash-grey. H = 5·5. G = 2·373...2·377.

In the matrass yields water. Before the blowpipe melts easily, with intumescence and evolution of sulphurous acid, into a blebby opaque glass. Is decomposed by concentrated hydrochloric acid disengaging hydrosulphuric acid and forming a jelly of silica. Boiling water dissolves out sulphate of lime.

Analyses of ittnerite by C. Gmelin and Whitney:—

Silica	34·02	35·69
Alumina	28·40	29·14
Red oxide of iron . . .	0·62	—

Lime	7·27	5·64
Soda	12·15	12·57
Potash	1·57	1·20
Sulphuric acid	2·86	4·62
Chlorine	0·75	1·25
Water and loss . . .	10·76	9·83

In crystals, cleavable, columnar and granular masses.

Is found in basalt on the Eichberg at Ober-Rothweil on the Kaiserstuhl in Baden.

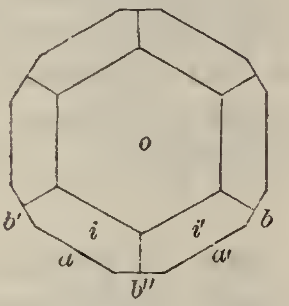
234. DAVYNE.—Cancrinite; Hausmann. Davyn; Haidinger.

Rhombohedral. 100,111 = 59° 14′·6.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *i* 231, *x* 120. The face *x* is in the zone *oa*.

ao	90°	0′
aa′	60	0
ba′	30	0
io	25	53
xo	44	8
ii′	25	13
xx′	40	46

FIG. 410.



Cleavage. *a*, perfect. Fracture conchoidal. Translucent. Lustre vitreous...pearly on the cleavage planes, on the other surfaces fatty. Colourless, white, rose-red. H = 5·5. G = 2·42 ...2·46.

Before the blowpipe easily fusible into a blebby glass. Soluble with effervescence in hydrochloric acid, forming a jelly.

Analyses of rose-red davyne, G = 2·453, (cancrinite) *a*, *b* from the Ilmen mountains by G. Rose, of green davyne, G = 2·461, *c* from Lichfield in the State of Maine, of a yellow variety, G = 2·448, *d*, *e*, *f* from Lichfield by Whitney:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	40·59	40·26	37·20	37·42	37·89	37·84
Alumina	28·29	28·24	27·59	27·70	27·39	28·26
Ox. iron, man. .	—	—	0·27	0·86	0·64	
Lime	7·06	6·34	5·26	3·91	3·88	3·82
Soda	17·38	17·66	20·46	20·98	21·24	20·94
Potash	0·57	0·82	0·50	0·67		
Carbonic acid . .	6·38	6·38	5·92	5·95	5·95	5·95
Water	—	—	3·28	2·82	2·82	2·82

In crystals, cleavable and columnar masses.

Is found in cavities in lava at Bosce Reale and in the cavities of ejected rocks on Vesuvius, and at Lichfield in the State of Maine, the red davyne (cancrinite) in the miascite of the Ilmen mountains in the Ural. In the variety to which the name cavolinite has been given the faces *a* have a pearly lustre.

We have not seen the reputed davyne from Lichfield, Maine, nor from the Ilmen mountains—the transfer of the name cancrinite to which latter mineral has tended to increase the confusion of our nomenclature.

HYDROUS SILICATES.

235. DIOPTASE.—Dioptase; Phillips, Hauy. Rhomboedrischer Smaragd-Malachit; Mohs. Dioptas; Hausmann, Haidinger.

Rhombohedral. 100,111 = 50° 39′.

a $01\bar{1}$, k $5\bar{1}\bar{4}$, l $5\bar{2}\bar{3}$, g $7\bar{2}\bar{5}$, r 100, i $\bar{1}22$, e 011, x $03\bar{1}$, z $07\bar{1}$, u $11\,0\,\bar{1}$, t $21\bar{1}$, v $74\bar{5}$. The forms k, l, g, x, z, u, v are hemihedral with parallel faces.

aa'	60°	0′	ra'	47°	57′	tr	33°	36′
ka'	10	54	ee'	53	36	tr'	62	43
ga'	16	6	rr'	84	6	va	29	0
la'	23	25	ir'	45	30	va'	49	1
xa'	29	0	ta	56	24	vr	41	22
za'	39	44	ta'	33	24	vr'	62	46
ua'	42	44						

FIG. 411.

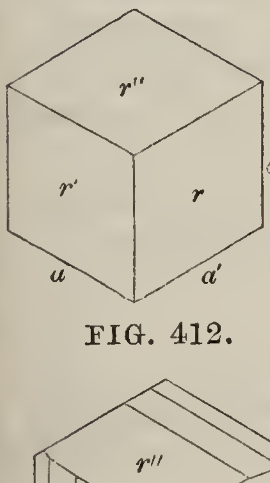


FIG. 412.

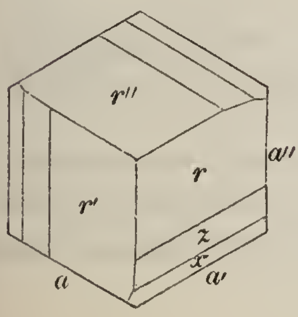
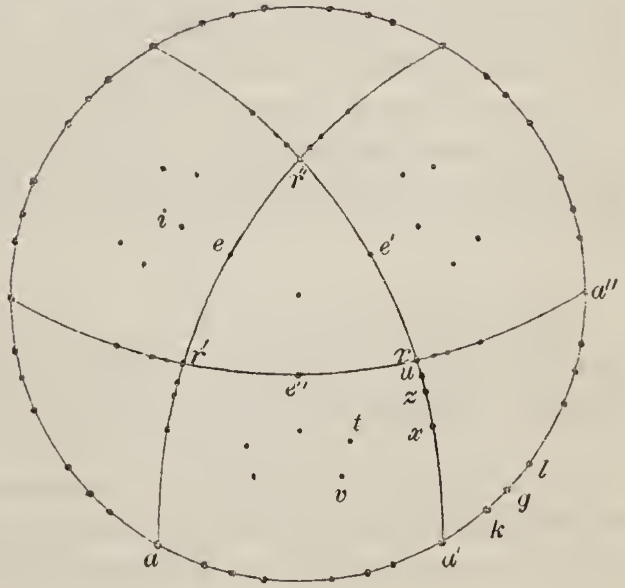


FIG. 413.



Combinations. *ar*, *ari*, *art*, *aru′*, *arx′z′*, *arz′u′*, *ark′g′*, *arx′z′l′*, *arx′z′v*‵. Twins. Twin-face *e*. Cleavage. *e*, perfect. The faces *r* striated parallel to the alternate intersections of *r*, *a*; *a* striated parallel to the intersections with *r*. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous inclining to resinous. $\mu = 1{\cdot}667$, $\mu' = 1{\cdot}723$. Emerald-green, sometimes verdigris-green. Streak green. Brittle. H = 5·0. G = 3·27...3·348.

In the matrass yields water and turns black. Before the blowpipe on charcoal becomes black in the outer flame, and red in the inner flame without melting; imparts a green colour to the flame. With borax and salt of phosphorus yields the reaction of copper, leaving a skeleton of silica in the latter. With soda on charcoal yields a bead of copper. Soluble in nitric and hydrochloric acids, forming a jelly of silica. Is decomposed by ammonia leaving a residue of silica.

$\dot{\mathrm{C}}\mathrm{u}\ddot{\mathrm{S}}\mathrm{i} + \dot{\mathrm{H}}$, oxide of copper 49·93, silica 38·74, water 11·33.

Analyses *a*, *b* by Hess, *c* by Damour:—

	a	*b*	*c*
Silica	36·60	36·85	36·47
Oxide of copper	48·89	45·10	50·10
Water	12·29	11·52	11·40
Alumina	—	2·36	—
Protoxide of iron	2·00	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	0·42
Lime	—	3·39	—
Magnesia	—	0·22	—
Carbonate of lime	—	—	0·35

Is found in crystals and massive, in narrow veins and cavities in a bed of compact limestone, in the Kirghese steppes, about 100 wersts to the N. W. of the Russian settlement of Kar-Karaly, on the western slope of the Altyn-Tubeh hills, towards a stream called Altyn-Szu, a few wersts to the south of its confluence with the Little Nura.

The forms and angles are deduced from the observations of Kenngott, communicated to the editors by Mr. Lettsom.

236. CHRYSOCOLLA. — Chrysocolla; Phillips. Cuivre hydro-siliceux; Hauy. Euchromatischer Opalin-Allophan; Mohs. Kieselmalachit; Hausmann. Chrysokolla; Haidinger.

Amorphous. Fracture conchoidal. Semi-transparent... translucent on the edges. Lustre resinous. Green, sky-blue. Streak greenish-white. Slightly brittle. H = 2·0...3·0. G = 2·0 ...2·2.

In the matrass yields water. Before the blowpipe becomes black in the outer flame, and red in the inner flame, without melting. With salt of phosphorus yields the reaction of copper, and a skeleton of silica. With soda yields metallic copper. With borax in the outer flame forms a green glass which, in the inner flame, becomes red with globules of reduced copper. Is decomposed by hydrochloric or nitric acid leaving a residue of silica in powder.

$\dot{Cu}\ddot{Si} + \dot{H}^2$, oxide of copper 44·85, silica 34·80, water 20·35.

Analyses of chrysocolla from Bogoslowsk *a* by v. Kobell, *b* from New Jersey by Bowen, *c* from Strömsheien in Norway by Scheerer, *d* from Franklin in New Jersey by Beck, *e* from Somerville, *f* from Bogoslowsk, both by Berthier:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	36·54	37·25	35·14	40·0	35·4	35·0
Ox. copper	40·00	45·17	43·07	42·6	35·1	39·9
Red ox. iron	1·00	—	1·09	1·4	—	3·0
Water	20·20	17·00	20·36	16·0	28·5	21·0
Gangue	2·10	—	—	—	1·0	1·1

Is found accompanying malachite and other ores of copper at Saska, Moldawa and other places in the Banat, Herrengrund in Hungary, Falkenstein near Schwatz in the Tyrol, Dreyhaken and Kupferberg in Bohemia, Saida and Schneeberg in Saxony, Bogoslowsk in the Ural, Kolywan in the Altai (pseudomorphous after cerussite), Molina and Linares in Spain, Strömsheien in Sätersdalen in Norway, Somerville in New Jersey, Cornwall, pseudomorphous after tamarite, Mexico, Chile, Burra Burra in Australia.

237. CERERITE.—Cerite; Phillips. Cerium oxidé silicieux rouge; Hauy. Untheilbares Cerer-Erz; Mohs. Cererit; Hausmann, Haidinger.

In short six-sided prisms. Traces of cleavage. Fracture uneven and splintery. Translucent on the edges...opaque. Lustre adamantine...resinous. Cove-brown...cherry-red, reddish-grey. Streak greyish-white. Brittle. H = 5·5. G = 4·9 ...5·0.

In the matrass yields water. Before the blowpipe infusible; turns yellow. With borax in the outer flame is slowly soluble into a dark yellow glass, which grows paler on cooling; in the inner flame shows a feeble reaction of iron. With soda melts into a dark yellow slag. In powder is easily soluble in hydrochloric acid, leaving a jelly of silica.

$\dot{R}\ddot{Si} + \dot{H}^2$, where $\dot{R}$ denotes the protoxides of cerium, lanthanium, and didymium.

Analyses of cererite *a* by Vauquelin, *b* by Hisinger, *c* by Hermann:—

	a	*b*	*c*
Carbonic acid	—	—	4·62
Silica	17	18·00	16·06
Protox. cerium	67	68·59	26·55
Ox. lanthanium	—	—	33·38
Alumina	—	—	1·68
Red ox. iron	2	2·00	3·53
Lime	2	1·25	3·56
Ox. manganese	—	—	0·27
Copper	—	—	trace
Water	12	9·60	9·10

The cererite analyzed by Hermann is supposed to have contained a mechanical mixture of carbonate of lime.

Was found in crystals and granular masses in St. Göran's mine at Riddarhytta in Sweden.

A mineral containing cerium (Hermann's ochroit) was found by Klaproth to consist of: silica 34·50, oxide of cerium 54·5, red oxide of iron 3·50, lime 1·25, water 5·00.

238. SMITHSONITE.—Siliceous oxide of zinc; Phillips. Zinc oxidé silicifere; Hauy. Prismatischer Zink-Baryt; Mohs. Zinkglas; Hausmann. Galmei; Haidinger.

Prismatic. 011,010=58°20′; 101,001=25°46′·5; 110,100=51°56′·5.

a 100, *b* 010, *c* 001, *e* 011, *u* 021, *w* 031, *h* 102, *l* 101, *f* 201, *v* 301, *q* 501, *r* 701, *m* 110, *g* 310, *k* 510, *s* 211, *t* 231, *x* 411, *z* 121, *n* 341. The forms *c*, *e*, *u*, *w*, *k*, *f*, *v*, *q*, *r*, *t*, *z*, *n* appear to be generally hemihedral with symmetric faces; *l*, *s* are also frequently hemihedral, *l* or *s* and the other combinations of hemihedral forms being on opposite sides of the zone *ab*.

bc	90°	0′	*hc*	13°	34′	*ma*	51°	57′
ca	90	0	*lc*	25	47	*mb*	38	3
ab	90	0	*fc*	44	0	*ga*	23	4
ec	31	40	*vc*	55	23	*ka*	14	20
uc	50	58	*qc*	67	30	*xa*	31	19
wc	61	37	*rc*	73	31	*xb*	74	10

xc	63° 45′	*zb*	42° 0′	*tc*	64° 24′
sa	50 35	*zc*	52 57	*na*	61 27
sb	66 5	*ta*	65 20	*nb*	35 30
sc	48 54	*tb*	36 55	*nc*	70 42
za	73 5				

FIG. 414.

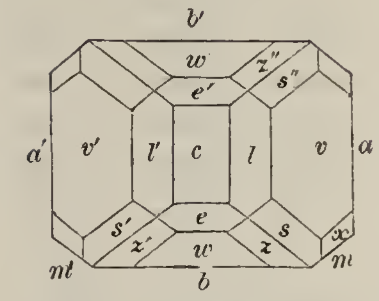


FIG. 415.

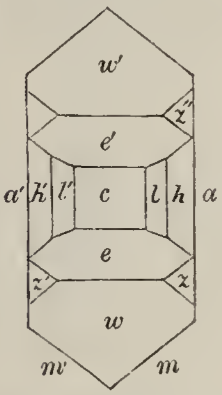
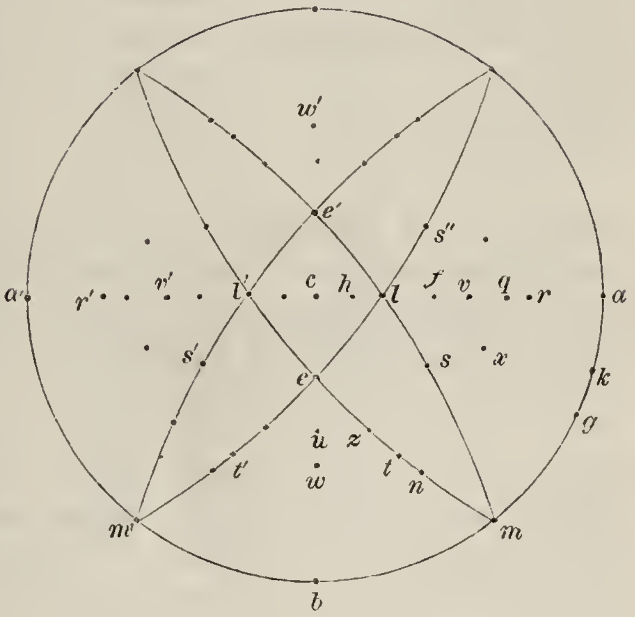


FIG. 416.



Combinations. *wv*, *amc′s‵.w′*, *amw′e′ls‵*, *amw′l′s‵..e′.v′.c′*, *abme′l′e′w′s‵.f′.v′.kr′n′*, *abmsc′l′e′w′v′z′x′*. Twins. Twin-face *e*. The faces *a* striated parallel to their intersections with *m*. Cleavage. *e*, *m*, both easily obtained, the latter very perfect. *c*, traces. Fracture uneven. Transparent...translucent. Lustre vitreous inclining to adamantine, on *a* pearly. Colourless, white, grey, yellow, brown, green, blue. Streak white. Brittle. H = 5·0. G = 3·35...3·50. Phosphoresces when rubbed. The crystals are pyroelectric. The analogous pole being at the end which has any of the hemihedral forms *c′*, *e′*, *u′*, *w′*, *h′*, *f′*, *v′*, *q′*, *r′*, *z′*, *t′*, *n′*, and the antilogous pole at the end which has the hemihedral form *s‵*.

In the matrass yields water and turns white. Before the blowpipe on charcoal swells and shines with a green light, melts with difficulty on the edges. Alone or with soda it deposits a slight sublimate. With solution of cobalt becomes blue, with spots of green. With borax melts into a clear glass which becomes opaque on cooling. Is soluble in acids, forming a jelly of silica. On adding ammonia to the solution a precipitate falls which is soluble in excess of ammonia. Partially soluble in potash.

$\dot{Z}n^2\ddot{S}i + \dot{H}$, silica 25·48, oxide of zinc 67·07, water 7·45.

Analyses of smithsonite *a* from Limburg by Berzelius, *b* from Limburg, *c* from the Breisgau, both by Berthier, *d* from Rezbanya by Smithson, *e* from Leadhills, G = 3·164, by Thomson :—

	a	*b*	*c*	*d*	*e*
Silica	24·89	25·0	25·5	25·0	23·2
Oxide of zinc . . .	66·84	66·0	64·5	68·3	66·8
Oxides of lead and tin	0·28	—	—	—	—
Water	7·46	9·0	10·0	4·4	10·8
Carbonic acid . . .	0·54	—	—	—	—

Analyses of smithsonite *f* from Nertschinsk, G = 3·871, *g* from Nertschinsk, G = 3·435, both by Hermann, *h* from Tarnowitz by Rammelsberg, *i*, *k* from Altenberg, G = 3·43...3·49, *l* from Rezbanya, all by Monheim :—

	f	*g*	*h*	*i*	*k*	*l*
Silica	25·38	25·96	24·99	25·40	24·31	25·34
Oxide of zinc . . .	62·85	65·66	68·66	67·05	65·74	67·02
Oxide of lead . .	2·70		(red ox. iron		0·43	0·68)
Water	9·07	8·38	7·75	7·47	7·51	7·58
Carbonic acid . .	—	—	—	0·31	0·31	0·35

In attached crystals, forming radiating groups, and in columnar or granular masses, usually in limestone.

Is found at Brilon, Iserlohn, at Altenberg near Aix-la-Chapelle, Moresnet near Liege, Bleiberg, Raibel and Rossegg in Carinthia, near Tarnowitz in Silesia, Olkucz and Miedziana-Gora in Poland, Truskawize in Gallicia, Hofsgrund, Zähringen and Badenweiler in Baden, Matlock in Derbyshire, Flintshire and the Mendip Hills in England, Wanlock-head and Lead hills in Scotland, Feigenstein in the Tyrol, Rezbanya in Hungary, Dognazka and Saska in the Banat, Alcarez in Spain, Nertschinsk and the Sirianow and Tschagirsk mines near Koliwan in Siberia, pseudomorphous after calcite in the Rammelsberg mine near Goslar in the Harz.

239. DATHOLITE.—Datholite; Phillips. Chaux boratée-siliceuse; Hauy. Prismatischer Dystom-Spath; Mohs. Datolith; Hausmann, Haidinger.

Prismatic. 011,010=57° 43′; 101,001=26° 34′; 110,100=51° 38′.

a 100, *b* 010, *c* 001, *o* 021, *r* 032, *d* 011, *s* 203, *φ* 101, *f* 403, *x* 201, *v* 301, *u* 401, *t* 310, *g* 210, *m* 110, *n* 111, *z* 221, *y* 441, *θ* 212, *w* 423, *e* 211, *h* 421, *l* 411, *k* 511, *i* 321, *q* 121, *p* 132, *ζ* 122. The forms *φ*, *f*, *x*, *h*, *n*, *e*, *i*, *l*, *w*, *θ*, *k* are frequently hemihedral with parallel faces.

dc	32°	17′	*ζa*	78°	4′	*θa*	63°	10′
rc	43	27	*qb*	41	30	*wa*	58	26
oc	51	38	*nb*	60	32	*wb*	70	42
bc	90	0	*θb*	74	47	*pb*	47	25
sc	18	26	*nc*	38	51	*ζb*	58	30
φc	26	34	*zc*	58	10	*ζc*	34	11
fc	33	41	*yc*	72	45	*qc*	53	39
xc	45	0	*ha*	38	51	*zb*	48	14
vc	56	19	*ia*	47	2	*eb*	65	56
uc	63	26	*za*	58	10	*pa*	79	43
ac	90	0	*qa*	72	45	*pc*	44	25
ta	22	50	*yb*	41	43	*lc*	64	33
ga	32	17	*hb*	60	32	*kc*	68	48
ma	51	38	*lb*	74	13	*kb*	76	48
ba	90	0	*θc*	30	36	*ic*	63	0
ka	25	19	*wc*	38	15	*ib*	54	58
la	30	36	*ec*	49	47	*ya*	53	39
ea	49	47	*hc*	67	5			
na	67	5						

FIG. 417.

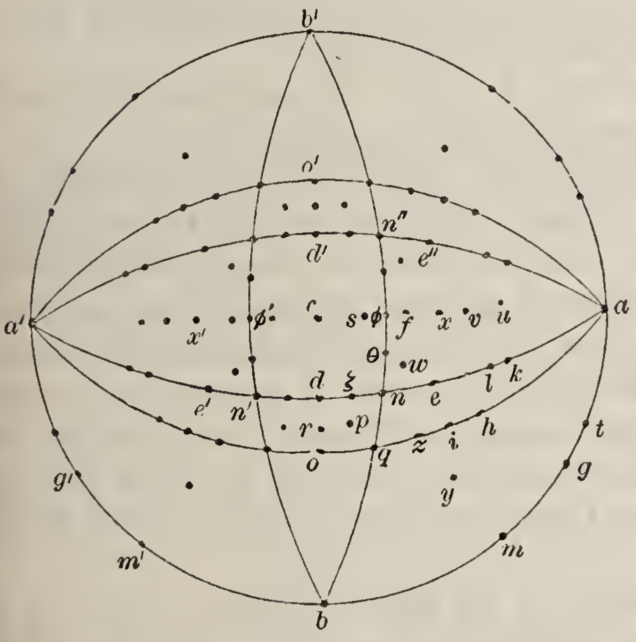


FIG. 418.

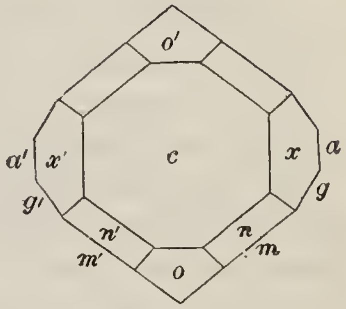
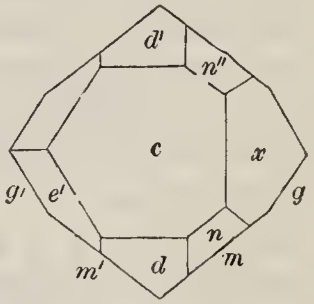


FIG. 419.



Combinations. *cmg*, *cn′omg*, *cn′omgx′a*, *cnomgd*, *cn‵x‵de′mg*, *cnx‵q‵doe′i″mgb*, *agdot‵f‵x‵h‵e′w′θ′*, *cnx‵q‵dr‵oe′p′i′l′h′k′mg*. The faces *x* are striated parallel to their intersections with *c* and *p*; *m*, *g* striated parallel to their intersections with each other;

d, *n* rough. Cleavage. *m* imperfect, very difficult to obtain; *a* rather more easily obtained. Fracture imperfect conchoidal ...uneven. Translucent...transparent. Lustre vitreous, resinous on surfaces of fracture. White, inclining to green, yellow and grey. Streak white. Brittle. H = 5·5. G = 2·8...3·0.

In the matrass yields water. Before the blowpipe intumesces, melts readily into a clear glass, and imparts a green colour to the flame. Is soluble in salt of phosphorus leaving a skeleton of silica. In powder is easily and completely decomposed by hydrochloric acid, leaving a jelly of silica. Alcohol added to the solution evaporated to dryness, burns with a green flame.

$\dot{\mathrm{C}}\mathrm{a}^2\ddot{\mathrm{S}}\mathrm{i} + \dddot{\mathrm{B}}\ddot{\mathrm{S}}\mathrm{i} + \dot{\mathrm{H}}$, silica 38·13, lime 34·68, boracic acid 21·62, water 5·57.

Analyses of datholite from Arendal *a* by Vauquelin, *b*, *c* by Rammelsberg, from Andreasberg, *d* by Stromeyer, *e* by Du Menil, *f* by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	36·66	37·65	37·52	37·36	38·51	38·48
Lime	34·00	35·41	35·40	35·67	35·59	35·64
Boracic acid . . .	21·67	21·24	21·38	21·26	21·34	20·31
Water	5·50	5·70	5·70	5·71	4·60	5·57

In attached crystals; massive, granular, columnar; in beds, veins, and in the cavities of amygdaloidal rocks.

By exposure to the weather it loses its transparency and lustre, becomes friable and at last falls to pieces.

Is found near Arendal in Norway in a bed of magnetite in gneiss, in the island of Utö, near Andreasberg in veins in diabase and in veins of silver ores in slate, on the Geisalp near Sonthofen in Bavaria in veins of calcite in sandstone, on the Theiss near Klausen in the Tyrol, at Niederkirchen near Wolfstein in Rhenish Bavaria, in veins in serpentine near Toggiana in Modena, Monte Catini in Tuscany and Reggio in Italy, Middlefield in Connecticut, Bergen hill in New Jersey in greenstone, the Salisbury Crags near Edinburgh, Glen Farg in Perthshire.

The forms *z*, *y* were observed by Mr. Brooke. *s*, *v*, *u*, *w*, *ζ* occurred in a crystal from Andreasberg. In the figure of a crystal of datholite, given in the third edition of Phillips, p. 380, under the name of humboldtite, *h*, M, *e*, e_2, *a*, a_2, a_3, *g*, g_2, g_3 denote respectively the forms *a*, *g*, *d*, *o*, *φ*, *f*, *x*, *e*, *w*, *θ*.

The faces *c*, though bright, are frequently very uneven, and incapable of affording good measurements with the reflective goniometer. This circumstance and the occurrence of hemihedral forms have been the occasion of the separation of datholite into two species and the placing one of them under the oblique system. The measurements of good crystals, however, reconcile these forms and show that they are both prismatic. It appears also from Haidinger's observations that the axes of optical elasticity are parallel to the intersections of the faces *a*, *b*, *c*. This fact is consistent with the supposition that the crystals are prismatic.

Botryolite, supposed by some mineralogists to constitute a distinct species, according to Breithaupt, is merely an amorphous variety of datholite. It occurs in fibrous reniform masses, of a white, grey or red colour, with calcite, quartz, tourmaline and pyrite, in a bed of magnetite in gneiss in the Oestre-Kjenlie mine near Arendal. H = 5·0...5·5. G = 2·885...2·901. Chemical characters the same as those of datholite. Analyses of botryolite, not quite free from a mechanical admixture of calcite, by Rammelsberg, who considers it to differ essentially from datholite, and to contain two equivalents of water, on which supposition however the water ought to amount to 10·5 per cent.

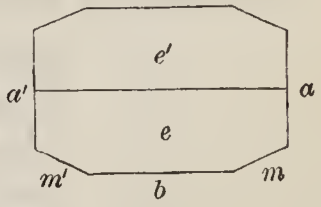
Silica	36·09	36·39
Lime	35·21	34·27
Boracic acid	19·34	18·34
Water	8·63	not det.
Alumina and red oxide of iron .	—	0·77

240. PICROSMINE. — Picrosmine; Dufrénoy. Prismatischer Pikrosmin-Steatit; Mohs. Pikrosmin, Hausmann, Haidinger.

Prismatic. 011,010=58° 54′; 101,001=16° 48′; 110,100=63° 26 .

ab	90°	0′
ea	90	0
ma	63	26
mm′	53	8
eb	58	54
ee′	62	12

FIG. 420.



Cleavage. *a*, very perfect; *b*, less perfect; *e*, less perfect; *m*, least perfect. Fracture uneven. Translucent on the edges ...opaque. Lustre, on *a* pearly, on the other faces inclining to vitreous. Greenish-white...blackish-green. Streak white. Very sectile. Yields an argillaceous odour when moistened. H = 2·5 ...3·0. G = 2·59...2·66.

In the matrass yields water and turns black. Before the blowpipe becomes white and hard, but does not melt. With borax fuses into a transparent bead. Is soluble in salt of phosphorus leaving a skeleton of silica. With solution of cobalt becomes red.

$2\dot{Mg}\ddot{Si} + \dot{H}$, magnesia 36·94, silica 55·02, water 8·04.

Analysis of picrosmine from Presnitz by Magnus:—

Silica	54·89
Magnesia	33·35
Alumina	0·79
Red oxide of iron	1·40
Protoxide of manganese . . .	0·42
Water and some ammonia . .	7·30

Is found in crystalline masses, columnar or granular, in a bed in the iron mine of Engelsburg near Presnitz in Bohemia, on the Greiner in the Tyrol in talcose or chloritic slate, near Waldheim in Saxony in veins in serpentine.

241. THORITE.—Thorite; Beudant. Thorit; Mohs, Hausmann, Haidinger.

Fracture conchoidal. Lustre vitreous. Black. Streak dark brown. Brittle. H = 4·5. G = 4·63.

Infusible before the blowpipe. Easily soluble in borax, forming a glass coloured by iron; on the addition of nitre yields the reaction of manganese. Before ignition gelatinizes in hydrochloric acid; after ignition is but slightly acted upon by it.

$\dot{Th}^2\ddot{Si} + H^2$.

Analysis by Berzelius:—

Silica	18·98
Thorine	57·91
Lime	2·58
Red oxide of iron	3·40
Oxide of manganese . .	2·39
Magnesia	0·36
Oxide of uranium	1·61
Oxide of lead	0·80
Oxide of tin	0·01

Potash	0·14
Soda	0·10
Alumina	0·06
Water	9·50
Insoluble matter	1·70

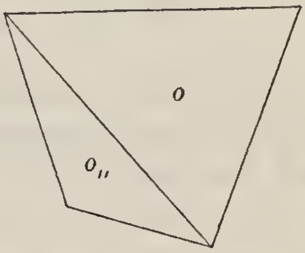
Is found with brown mesotype (bergmannite) on the island of Lövö near Brevig in Norway.

242. TRITOMITE.—Tritomit; Weibye.

Cubic.

o 111. The form *o* is hemihedral with inclined faces.

FIG. 421.



$oo_{,,}$ 109° 28′

The faces dull. Cleavage not observable. Fracture conchoidal. Opaque... translucent on the edges. Lustre vitreous, inclining to metallic on the surface of fracture. Dark brown. Streak yellowish-brown. Very brittle. H = 5·5. G = 4·16...4·66.

In the matrass yields water and traces of fluorine. Becomes white before the blowpipe and cracks. With borax in the outer flame forms a reddish-yellow glass, which becomes colourless on cooling. In powder is decomposed by hydrochloric acid, leaving a jelly of silica.

Approximate analysis of a small quantity by Berlin:—

Silica	20·13
Oxide of cerium	40·36
Oxide of lanthanium	15·11
Lime	5·15
Alumina	2·24
Yttria	0·46
Magnesia	0·22
Soda	1·46
Protoxide of iron	1·83
Manganese, copper, tin, scheelium	4·62
Loss by ignition	7·86

Is found in single imbedded crystals in the island of Lamö near Brevig in Norway, in a coarse-grained syenite with leucophane, mosandrite, katapleiite, &c.

243. KATAPLEIITE.—Katapleiit; Weibye.

Cleavage in one direction, perfect. Fracture splintery. Opaque...translucent on the edges. Lustre vitreous, feeble. Light yellowish-brown. Streak yellow. H = 6·0. G = 2·8.

Melts easily into a white enamel before the blowpipe. Dissolves in borax into a transparent colourless glass. With solution of cobalt becomes blue. In powder is decomposed by hydrochloric acid without forming a jelly.

Analyses by Sjögren :—

Silica	46·83	46·52
Zirconia	29·81	29·33
Alumina	0·45	1·40
Soda	10·83	10·06
Lime	3·61	4·66
Protoxide of iron	0·63	0·49
Water	8·86	9·05

Is found in coarse-grained syenite with mosandrite, leucophane, zircon, ægyrine, tritomite, &c., in the island of Lamö near Brevig.

The earth called zirconia agrees perfectly in its characters with the earth in the zircons from Friedrichswärn.

244. ANTHOSIDERITE.—Anthosiderit; Hausmann, Haidinger.

Fibrous. Opaque. Lustre silky. Ochre-yellow...yellowish-brown. Streak the same, lighter. Very tough. H = 6·5. G = 3·0.

Before the blowpipe melts with difficulty into an iron-black magnetic slag. Is decomposed by hydrochloric acid.

$\overset{\cdots}{\bar{\text{F}}\text{e}}\,\overset{\cdot\cdot}{\text{Si}}^4 + \dot{\text{H}}$.

Analyses by Schnedermann :—

Silica	61·14	59·03
Red oxide of iron	34·63	35·35
Water	3·59	3·59

Is found with magnetite at Antonio Pereira, in Minas Geraes in the Brazils.

245. KROKYDOLITE.—Krokydolith; Mohs, Hausmann, Haidinger.

In aggregations of delicate, easily separable, parallel fibres, like asbestus. The fibres are very tough, elastic and flexible. In thin filaments translucent. Lustre silky. Indigo-blue. Streak lavender-blue. H = 4·0...4·5. G = 3·2...3·3.

In the matrass yields water, and becomes red. Before the blowpipe melts easily into a bright, black, magnetic bead. Thin fibres melt in the flame of a spirit lamp. With borax melts easily into an olive-green glass. In salt of phosphorus leaves a skeleton of silica. Not sensibly acted upon by acids.

Analyses by Stromeyer of fibrous and earthy varieties from Oranje River :—

Silica	50·81	51·64
Protoxide of iron	33·88	34·38
Oxide of manganese . . .	0·17	0·02
Magnesia	2·32	2·64
Lime	0·02	0·05
Soda	7·03	7·11
Water	5·58	4·01

Is found with magnetite near Oranje River in South Africa; at Stavärn in Norway in zircon-syenite; in Greenland; at Golling in Salzburg with quartz in gypsum.

246. KARPHOLITE.—Karpholite; Phillips, Hauy. Karpholith; Mohs, Hausmann, Haidinger.

In aggregations of acicular and capillary crystals. Feebly translucent...opaque. Lustre vitreous, inclining to pearly. Yellow. Streak white. H = 5·0...5·5. G = 2·935.

In the matrass yields water, and a trace of fluorine. Before the blowpipe intumesces and melts into a brown slag. With borax in the outer flame forms a purple glass. Is scarcely acted upon by hydrochloric acid.

Analyses by Steinmann and Stromeyer :—

Silica	37·53	36·15
Alumina	26·47	28·67
Oxide of manganese $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ . .	18·33	19·16
Red oxide of iron	6·27	$\dot{\mathrm{F}}\mathrm{e}$ 2·29
Lime	—	0·27
Water	11·36	10·78
Hydrofluoric acid	—	1·47

Is found with fluor in granite at Schlackenwald in Bohemia.

247. PREHNITE.—Prehnite; Phillips, Hauy. Axotomer Triphan-Spath; Mohs. Prehnit; Hausmann, Haidinger.

Prismatic. 011,010 = 44° 53′; 101,001 = 40° 9′; 110,100 = 49° 58′.

a 100, *b* 010, *c* 001, *n* 011, *v* 012, *o* 401, *m* 110, *r* 443, *s* 441. *s* truncates the edge *mc*.

bc	90°	0′
ca	90	0
ab	90	0
nc	45	7
vc	26	40
oc	73	30
ma	49	58
mb	40	2
mm′	80	4
ra	56	3
rb	48	20
rc	60	15
sc	79	13

FIG. 422.

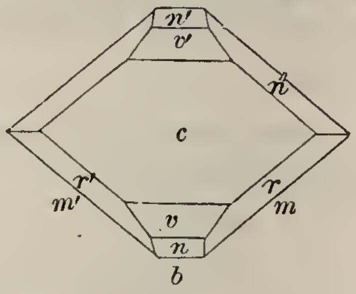
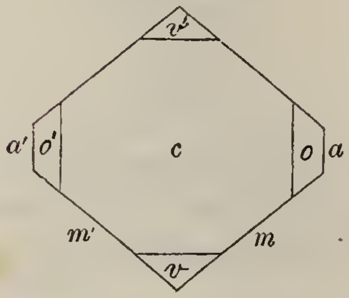


FIG. 423.



Combinations. *cm.a, cma.o, cnomab, crmvnb.* The faces *c* striated parallel to their intersections with *n* and *o*; *a, m* striated parallel to their intersections with *c.* Cleavage. *c,* tolerably perfect; *m,* far less perfect. Fracture uneven. Semi-transparent... translucent. Lustre vitreous; *c,* pearly. Various shades of light green. Streak white. Brittle. H = 6·0...7·0. G = 2·92...3·01. Pyroelectric, the analogous poles being in the middle of the faces *c,* and the antilogous poles at the extremities of a diagonal parallel to the edge *ac.*

In the matrass yields water without becoming opaque. Fuses before the blowpipe with intumescence into a blebby glass. In powder only partially soluble in hydrochloric acid. After ignition is completely decomposed by hydrochloric acid, forming a jelly of silica.

$2\dot{\mathrm{Ca}}\ddot{\mathrm{Si}} + \overset{\cdots}{\mathrm{Al}}\ddot{\mathrm{Si}} + \dot{\mathrm{H}}$, silica 44·27, alumina 24·57, lime 26·84, water 4·32.

Analyses of prehnite *a* from Ratschinges, *b* from Fassa by Gehlen, *c* from Ædelfors, *d* from Montblanc, *e* from Dumbarton, all by Walmstedt, *f* from Bourg d'Oisans by Regnault, *g* from the Radauthal in the Harz by Amelung:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Silica	43·00	42·87	43·03	44·71	44·10	44·50	44·74
Alumina . .	23·25	21·50	19·30	23·99	24·26	23·44	18·06
Red ox. iron .	2·00	3·00	6·81	1·25	0·74	4·61	7·38
Lime	26·00	26·50	26·28	25·41	26·43	23·47	27·06
Ox. mang. . .	0·25	0·25	0·15	0·19	—	Ṅa	1·03
Water	4·00	4·62	4·43	4·45	4·18	4·44	4·13

In attached crystals, frequently united by the faces *c* so as to form fan-shaped groups with curved faces; fibrous, globular and reniform; massive; pseudomorphous after analcime and leonhardite. In granite, greenstone, crystalline slate rocks, in the cavities of trap rocks.

Is found at Bourg d'Oisans in Dauphiné, at Ratschinges near Sterzing, the Seisseralp, and Mount Monzoni in the Fassathal in the Tyrol, Luz and Barèges in the Pyrenees, Mont Blanc, St. Gotthardt, Schwarzenberg in Saxony, the Saualp and other places in Carinthia, Reichenbach near Oberstein in the Palatinate, the Harz, Norway, Sweden, Massachusetts, the country of the Namaquas in South Africa, in Scotland in trap near Dumbarton, Hartfield Moss near Paisley, Friskie Hall near Glasgow, the Castle rock and Salisbury Crags near Edinburgh, the islands of Mull and Skye, in England at Woodford in Gloucestershire, Staffordshire, Botallack near the Land's End.

248. AGALMATOLITE.—Agalmatolite; Phillips. Talc glaphique; Hauy. Untheilbarer Glyphin-Steatit; Mohs. Agalmatolith; Hausmann, Haidinger.

Fracture splintery, uneven. White, pale grey, green, yellow, flesh-red. Streak white, shining. Slightly brittle, almost sectile. Unctuous. H = 3·0. G = 2·75...2·85.

In the matrass yields water. Before the blowpipe becomes white and melts only on the thinnest edges. With borax melts with intumescence into a colourless globule. Is decomposed by hot sulphuric acid, leaving a residue of silica.

Analyses of agalmatolite *a* from China, *b* from Nagyag, both by Klaproth, *c*, *d* from China by John, *e* of onkosine from Possegen by v. Kobell:—

	a	*b*	*c*	*d*	*e*
Silica	54·50	55·0	55·50	55·50	52·52
Alumina	34·00	33·0	30·00	31·00	30·88
Oxide of iron . . .	0·75	0·5	1·00	1·25	0·80

	a	*b*	*c*	*d*	*e*
Potash	6·25	7·0	6·25	5·25	6·38
Lime	—	—	1·75	2·00	$\dot{Mg}$ 3·82
Water	4·00	3·00	5·50	5·00	4·60

Is found in China, on the Ochsenkopf near Schwarzenberg in Saxony, at Nagyag in Hungary. Onkosine is found in apple-green round masses in dolomite at Possegen near Jamsweg in Lungau in Salzburg.

249. SOAPSTONE.—Soapstone; Phillips. Pierre de savon; Beudant. Pseudomorpher Glyphin-Steatit; Mohs. Seifenstein; Hausmann. Steatit; Haidinger.

Fracture splintery...uneven. Translucent on the edges. Dull. Yellowish-white, greyish-white, blueish-grey. Streak shining. Unctuous. Sectile. H = 1·5. G = 2·266.
In the matrass yields water. Before the blowpipe melts into a colourless blebby glass. Is completely decomposed by sulphuric acid.

Analyses of soapstone from Cornwall by Klaproth and Svanberg:—

Silica	45·00	46·8
Alumina	9·25	8·0
Red oxide of iron	1·00	0·4
Magnesia	24·75	33·3
Lime	—	0·7
Potash	0·75	—
Water	18·00	11·0

Is found in a vein of serpentine at the Lizard and near the Cheesewring at St. Clear in Cornwall.

250. OTTRELITE.—Ottrelit; Hausmann, Haidinger.

In six-sided prisms. Cleavage; perpendicular to the axes of the prism, perfect. Fracture uneven. In thin leaves translucent. Lustre, on the cleavage planes, vitreous inclining to waxy. Greyish-black, inclining to green. Streak greyish-white. Scratches glass. G = 4·4.
In the matrass yields water. Before the blowpipe melts with difficulty into a black magnetic globule. With borax shows the colour of iron. With soda the colour of manganese. In powder is acted on by hot sulphuric acid.

$3\dot{R}\ddot{Si} + \dddot{Al}^2\ddot{Si}^3 + \dot{H}^3$, where $\dot{R}$ is $\dot{Fe}$, $\dot{Mn}$.

Analyses by Damour:—

Silica	43·52	43·34
Alumina	23·89	24·63
Protoxide of iron . . .	16·81	16·72
Protoxide of manganese .	8·03	8·18
Water	5·63	5·66

Is found in small crystals imbedded in clay slate at Ottrez near Stavelot on the frontier of Luxemburg.

251. **BASTITE.**—Schiller spar; Phillips. Diallage métalloide; Hauy. Diatomer Schiller-Spath; Mohs. Schillerstein; Hausmann. Bastit; Haidinger.

Cleavage, very perfect in one direction; imperfect in a second direction; traces in other directions. Fracture uneven and splintery. In thin leaves translucent. Lustre pearly, inclining to adamantine on the cleavage planes. Olive and pistacio-green, passing into brown and yellow. Streak greenish-white. H = 3·5...4·0. G = 2·6...2·8.

In the matrass yields water. Before the blowpipe becomes brown and magnetic, but melts only on the edges of the thinnest splinters. With borax forms a glass which while hot shows the colour of iron, and when cold that of chrome. Completely decomposed by sulphuric acid; imperfectly by hydrochloric acid.

$4\dot{R}\ddot{Si} + \dot{Mg}\dot{H}^4$, where $\dot{R}$ is $\dot{Mg}$, $\dot{Ca}$, $\dot{Fe}$.

Analyses of crystalline bastite from the Harz *a*, *b*, of a compact variety *c*, all by Köhler:—

	a	*b*	*c*
Silica	43·90	43·07	42·36
Magnesia	25·86	26·16	28·90
Lime	2·64	2·75	0·63
Protoxide of iron	13·02	10·91	13·27
Protoxide of mangan. . .	0·53	0·57	0·85
Oxide of chrome	—	2·37	—
Alumina	1·28	1·73	2·18
Water	12·43	12·43	12·07

In *a* and *c* the protoxide of iron includes some oxide of chrome.

In crystalline plates imbedded in the massive variety, in the euphotide of the Baste and other places in the Harzburg Forest in the Harz.

252. SERPENTINE.—Serpentine; Phillips, Hauy. Prismatischer Serpentin-Steatit; Mohs. Serpentin; Hausmann, Haidinger.

Fracture flat conchoidal, splintery, uneven. Translucent... opaque. Lustre resinous, feeble...dull. Green of various shades, usually dull, passing into yellow and grey. Streak white, shining. Sectile. H = 3·0. G = 2·47...2·60.

In the matrass yields water, and turns black. Before the blowpipe turns white, and melts with difficulty on the thinnest edges. Dissolves slowly in borax. With solution of cobalt becomes pale red. In powder is completely decomposed by hydrochloric acid, and yet more readily by sulphuric acid.

$2\dot{M}g\ddot{S}i + \dot{M}g\dot{H}^2$, part of the magnesia being replaced by protoxide of iron.

Analyses of serpentine *a* from Fahlun, *b* fibrous (picrolite) from Taberg, *c* from Swärdsjö, *d* from Sahla, *e* from Massachusetts, *f* from Hoboken, all by Lychnell:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	41·95	40·98	41·58	42·16	43·20	41·67
Alumina	0·37	0·73	—	red ox.	iron	1·64
Protox. iron . . .	2·22	8·72	2·17	1·98	5·24	—
Magnesia	40·64	33·44	42·41	42·26	40·09	41·25
Water	11·68	12·86	11·29	12·33	11·42	13·80
Bitumen and $\ddot{C}$ . .	3·42	1·73	2·38	1·03	—	1·37

Analyses of serpentine *g* from Gornoschit near Katharinenburg by Schaffgotsch, *h* from Fahlun by Jordan, *i* by Marchand, *k* from Gullsjö in Wermland by Mosander, *l* fibrous (picrolite) from Philipstad in Wermland by Stromeyer, *m* pseudomorphous in the form of olivine, from Snarum by Hartwall:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	43·73	40·32	40·52	42·34	41·66	42·97
Alumina	0·81	—	0·21	($\dot{M}n$	2·25)	0·87
Protox. iron . . .	6·11	3·33	3·01	—	4·05	$\ddot{\bar{F}}e$ 2·48
Magnesia . . .	37·72	41·76	42·05	44·20	37·16	41·66
Water	11·63	13·54	13·85	12·38	14·72	12·02
Carbon. ac. . . .	—	—	0·30	0·89	—	

Analyses of serpentine *n* from Snarum by Scheerer, *o* from the Talov copper mine in the Ural, G = 2·55, by Ivanoff, *p* from Texas in Lancaster county Pennsylvania, G = 2·557, by Rammelsberg, *q* from Schwarzenberg in Saxony, pseudomorphous in the form of garnet, by Kersten, *r* from the Ural, G = 2·57, by Hermann, *s* from Villa Rota on the Po, G = 2·644, by Delesse:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	40·71	40·80	43·79	41·50	40·21	41·34
Alumina	2·39	3·02	—	—	1·82	3·22
Protox. iron	2·43	2·20	2·05	4·10	9·13	5·54
Protox. mangan.	—	0·20	—	0·50	—	—
Magnesia	41·48	40·50	41·03	40·34	35·09	37·61
Lime	—	0·42	($\dot{\mathrm{Na}}$	0·42)	—	—
Water	12·61	12·02	12·47	12·87	13·75	12·06

Analyses of serpentine *t* from Nanzenbach near Dillenburg by Schnabel, *u* from Richmond in New York by Beck, *v* from Bare Hills by Vanuxem, *w*, *x* (retinalite), G = 2·476...2·525, from Greenville in Canada, *y* from Grand Calumet island, all by T. S. Hunt:—

	t	*u*	*v*	*w*	*x*	*y*
Silica	41·70	41·00	42·69	39·34	40·10	41·20
Alumina	7·04	$\ddot{\mathrm{C}}$	0·87	—	—	—
Protox. iron	26·95	1·85	1·16	$\dddot{\mathrm{Fe}}$ 1·80	1·90	0·80
Magnesia	10·26	41·26	40·00	43·02	41·65	43·52
Lime	3·34	2·39	—	soda	0·90	—
Water	11·58	13·50	16·11	15·09	15·00	15·40

Analyses of the fibrous varieties *z* from Reichenstein (chrysotile) by v. Kobell, *α* from Reichenstein (metaxite) by Delesse, *β* mean of two analyses of metaxite by Kühn, *γ* from the Vosges, G = 2·219, by Delesse, *δ* from Baltimore (baltimorite) by Thomson, *ε* from Zöblitz, G = 2·60...2·65, by C. Schmidt:—

	z	*α*	*β*	*γ*	*δ*	*ε*
Silica	43·50	42·1	43·98	41·58	40·95	43·70
Alumina	0·40	0·4	—	0·42	1·50	2·76
Magnesia	40·00	41·9	40·80	42·61	34·70	29·96
Protoxide of iron	2·08	3·0	2·27	1·69	10·05	10·03
Soda	—	—	—	—	—	1·98
Water	13·80	13·6	12·65	13·70	12·60	12·27

A small quantity of chrome was found in serpentine from Zöblitz by Valentine Rose, in serpentine from Hoboken by Nuttal, and in serpentine from Vermont by Jackson.

Occurs in compact and fibrous masses forming rocks and in beds in slate, in veins, pseudomorphous in the form of olivine, garnet, augite, amphibole.

Is found in Saxony, Bohemia, Moravia, Austria, Stiria, Salzburg, the Tyrol, Hungary, Silesia, Italy, Corsica, Norway, Sweden, Siberia, the United States, England, Scotland. The cleavable variety (marmolite) is found in serpentine veins at

Hoboken in New Jersey, and on the Bare Hills near Baltimore in the United States. Fibrous varieties are found at Reichenstein in Silesia in compact serpentine, Taberg in Sweden, Baltimore in the United States, and in the Harzburg Forest in the Harz.

253. WÖRTHITE. — Wœrthite ; Dufrénoy. Wörthit ; Hausmann.

Cleavable in one direction. Feebly translucent. Lustre pearly. White. H = 7·0...7·5. G = 3·0.

In the matrass yields water. Infusible before the blowpipe. With solution of cobalt becomes blue. Not soluble in acids.

$\dddot{A}l^4\ddot{S}i^5 + \dot{H}^2$.

Analyses by Hess :—

Silica	40·58	41·00
Alumina	53·50	52·63
Magnesia	1·00	0·76
Water	4·63	4·63

In pebbles consisting of granular and columnar aggregations, from the neighbourhood of St. Petersburg.

254. ANTIGORITE.—Antigorite ; Dufrénoy. Antigorit ; Hausmann, Haidinger.

Cleavage in one direction. Transparent...translucent. Lustre feeble. Has two optic axes. Green. Streak white, shining feebly. H = 2·5. G = 2·62.

In the matrass yields water. Before the blowpipe melts on the edges of very thin splinters into a yellowish-brown enamel. Is decomposed with difficulty by hydrochloric acid, leaving the silica in flocks. Is more readily decomposed by sulphuric acid.

$3\dot{R}\ddot{S}i + \dot{M}g\dot{H}$, where $\dot{R}$ is $\dot{M}g$ and $\dot{F}e$.

Analyses by Schweizer :—

Silica	46·22	46·18
Magnesia	34·39	35·19
Protoxide of iron . . .	13·05	12·68
Alumina	2·08	1·89
Water	3·70	3·70

Is found in the valley of Antigorio near Domo d'Ossola in Piedmont.

255. STILPNOMELANE.—Stilpnomelan; Mohs, Hausmann, Haidinger.

Rhombohedral.

o 111 cleavage.

Cleavage. *o*, perfect. Opaque. Lustre vitreous, inclining to pearly. Black...blackish-green. Streak olive-green...greenish-grey. Rather brittle. H = 3·0...4·0. G = 3·0...3·4.

In the matrass yields water. Before the blowpipe melts into a black magnetic globule. Completely soluble in borax, imparting to it the colour of iron. Imperfectly decomposed by acids.

Analyses by Rammelsberg:—

Silica	43·19	46·50	45·43	46·17
Alumina	8·16	7·10	5·88	5·88
Protoxide of iron	37·05	33·89	35·38	35·82
Magnesia	3·34	1·89	1·68	2·67
Lime	1·19	0·20	0·18	—
Potash	—	—	—	0·75
Water	5·95	7·90	9·28	8·72

In crystalline and granular masses, and disseminated.

Is found with calcite, quartz, marcasite, pyrite in clay slate at Obergrund near Zuckmantel and at Spachendorf near Benisch in Silesia.

256. CRONSTEDTITE.—Cronstedtite; Phillips, Beudant. Rhomboedrischer Melan-Glimmer; Mohs. Cronstedtit; Hausmann, Haidinger.

Rhombohedral.

o 111, *b* $2\bar{1}\bar{1}$, *r* 100. The forms *o*, *r* are sometimes hemihedral with inclined faces.

bo	90°	0′
bb″	60	0

FIG. 424.

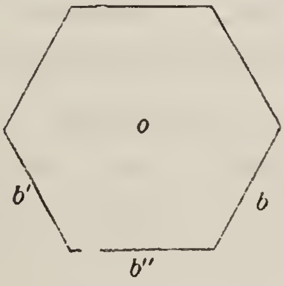
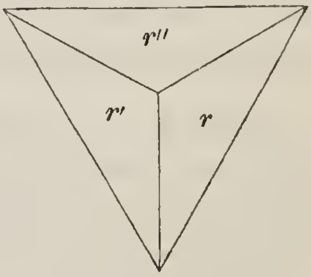


FIG. 425.



Combinations. *ob*, *o′r*‵ Cleavage. *o*, perfect; *b*, imperfect. *o*, smooth; the faces *b* striated parallel to their intersections with each other. Translucent...opaque. Lustre vitreous, bright. Black. Streak dark leek-green. Brittle. In very thin leaves flexible and elastic. H = 2·5. G = 3·348.

In the matrass yields water and traces of hydrofluoric acid. Before the blowpipe intumesces and melts on the edges into a blackish-grey slag. With borax and salt of phosphorus gives indications of iron, silica and manganese. The presence of manganese is shown by fusing it with soda on platinum foil. Is decomposed by hydrochloric acid, leaving a jelly of silica.

$\dddot{\not{\mathrm{F}}}\mathrm{e}^2\ddot{\mathrm{Si}} + 2\dot{\mathrm{F}}\mathrm{e}^2\ddot{\mathrm{Si}} + \dot{\mathrm{H}}^5$, part of the $\dot{\mathrm{F}}\mathrm{e}$ being replaced by $\dot{\mathrm{M}}\mathrm{g}$.

Analysis of cronstedtite from Przibram by Steinmann, corrected by v. Kobell:—

Silica	22·45
Red oxide of iron . . .	35·35
Protoxide of iron . . .	27·11
Oxide of manganese . .	2·88
Magnesia	5·08
Water	10·70

In crystals, reniform, columnar or fibrous masses.

Is found at Przibram in Bohemia, Wheal Maudlin in Cornwall, and the variety with hemihedral forms (sideroschisolite) at Conghonas do Campo in the Brazils with pyrrhotine and chalybite, and in Chile.

257. CLINTONITE.—Xanthophyllit; Hausmann. Clintonit; Haidinger.

Rhombohedral.

o 111 cleavage.

Cleavage. *o*, perfect. In thin leaves more or less transparent. Lustre on the cleavage planes vitreous, inclining to pearly, bright. Yellow...brown, green. H = 4·5...6·5. G = 3·01...3·10.

Infusible before the blowpipe. Soluble in borax, forming a clear glass. Is decomposed by strong hydrochloric acid, leaving a residue of silica. Brandisite is soluble in boiling sulphuric acid, but not in hydrochloric acid.

Analyses of clintonite *a* from Amity by Clemson, *b* from Slatoust (xanthophyllite) mean of four analyses by Meitzendorff, *c* by Plattner, *d* from Monzoni (brandisite) by v. Kobell:—

	a	*b*	*c*	*d*
Silica	17·0	16·30	21·4	20·00
Alumina	37·6	43·95	46·7	43·22
Magnesia	24·3	19·31	9·8	25·01

	a	*b*	*c*	*d*
Lime	10·7	13·26	12·5	4·00
Protoxide of iron . . .	5·0	2·53	4·3	$\overset{\dots}{\mathrm{\bar{F}e}}$ 3·60
Soda	—	0·61	$\dot{\mathrm{K}}$	0·57
Water	3·6	4·33	3·5	3·6

Occurs in six-sided plates and granular masses. The variety called xanthophyllite is found near Slatoust in the Ural. Clintonite is found in limestone at Amity in New York. Brandisite at Monzoni in the Fassathal in the Tyrol.

258. MASONITE.—Chloritspath; Mohs. Chloritoid; Hausmann, Haidinger. Masonite; Jackson.

Cleavage in one direction, very perfect. In thin leaves translucent. Lustre pearly. Blackish-green. Streak greenish-white. Brittle. H = 5·5...6·0. G = 3·45...3·55.

In the matrass yields water, and loses its lustre and transparency. Before the blowpipe fuses with difficulty on the edges into a black glass. In borax dissolves slowly into a clear glass coloured by iron. Not acted upon by acids.

Analyses of masonite *a* from Mramorskoi (chloritoid) by v. Bonsdorff, *b* from Natic by Whitney:—

	a	*b*
Silica	27·48	28·27
Alumina	35·57	32·16
Protoxide of iron	27·05	33·72
Protoxide of manganese . .	0·30	—
Magnesia	4·29	0·13
Water	6·95	5·00

Is found in crystalline, granular, curved lamellar aggregations, with diaspore in a vein in chlorite slate at Mramorskoi near Katharinenburg in Siberia, and Natic in Rhode Island.

259. PYROPHYLLITE.—Pyrophyllite; Beudant. Pyrophyllit; Mohs, Hausmann, Haidinger.

Prismatic.

In prisms having a single distinct cleavage parallel to the axis of the prism. Translucent, in thin leaves semi-transparent. Lustre pearly. Apple-green...white. Streak white. H = 1·0. G = 2·785.

In the matrass yields water. Before the blowpipe exfoliates and swells out into many times its original volume. Melts with great difficulty. With borax forms a clear glass. With solution of cobalt becomes blue. Is partially decomposed by sulphuric acid.

Analyses of pyrophyllite *a* from Beresowsk by Hermann, *b* from Spaa by Rammelsberg, *c*, *d* from Westana in Schonen by Sjögren:—

	a	*b*	*c*	*d*
Silica	59·79	66·14	67·77	65·61
Alumina	29·46	25·87	25·17	26·09
Red oxide of iron	1·80	—	0·82	0·70
Protoxide of manganese	—	—	0·50	0·09
Lime	—	0·39	0·66	0·69
Magnesia	4·00	1·49	0·26	0·09
Water	5·62	5·59	5·82	7·08

Is found in broad right-angled prisms and globular masses, imbedded in quartz veins in granite, at Beresowsk in the Ural, Ottrez and near Spaa in Belgium, the Brazils, in quartz with kyanite.

260. RIPIDOLITE.—Chlorite (in part); Phillips. Chlorit; G. Rose, Rammelsberg. Prismatischer Talk-Glimmer (in part); Mohs. Ripidolith; v. Kobell, Naumann, Breithaupt. Ripidolith, Kämmererit, Pennin; Hausmann, Haidinger.

Rhombohedral. 100,111 = 66° 2′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *r* 100, *z* $\bar{1}22$, *s* $\bar{1}11$, *l* $4\bar{1}\bar{1}$, *k* $6\bar{1}\bar{1}$, *u* $37\bar{1}$.

ao	90°	0′	*ro*	66°	2′	*ko*	75°	45′
bo	90	0	*zo*	66	2	*uo*	60	0
bb″	60	0	*so*	77	28	*zr′*	54	22
ab′	30	0	*lo*	79	55			

FIG. 426.

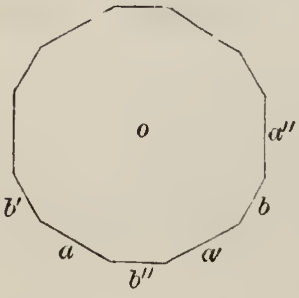


FIG. 427.

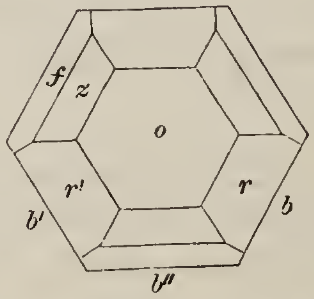
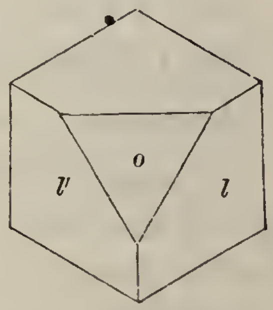


FIG. 428.



The faces *o* smooth but not even; the other faces in the zone *rz* striated parallel to their intersections with *o*. Cleavage.

o very perfect. Semi-transparent...translucent. Lustre vitreous, on *o* pearly. Green of various shades, violet (kämmererite). In a direction perpendicular to *o* leek-green approaching to emerald-green, in a direction parallel to *o* hyacinth-red or yellowish-green. In the latter direction more transparent than in the former. Streak white. In thin leaves flexible, but not elastic. H = 2·0...3·0. G = 2·615...2·774.

In the matrass yields water. Exfoliates before the blowpipe, becomes white, and melts on the edges into a white enamel. Is completely decomposed by hot sulphuric acid.

Analyses of ripidolite *a* from Schwarzenstein by Brüel, *b* from Achmatowsk by v. Kobell, *c* from Achmatowsk by Varrentrapp, all corrected by Rammelsberg, *d* from Mauléon by Delesse, *e* from Ala, *f* from Slatoust, both by Marignac :—

	a	*b*	*c*	*d*	*e*	*f*
Silica	31·47	31·14	30·38	32·1	30·01	30·27
Alumina	16·67	17·14	16·97	18·5	19·11	19·89
Red ox. iron . . .	3·36	—	—	—	4·81	4·42
Protox. iron . . .	2·95	4·55	4·55	0·6	—	—
Magnesia	32·56	34·40	33·97	36·7	33·15	33·13
Protox. mang. . . .	0·01	0·53	—	—	—	—
Water	12·43	12·12	12·63	12·1	12·52	12·54

Analyses of ripidolite *g* found near the river Balschoi Iremel in the Ural, *h* from the Schischminsk mountains in the Ural, H = 2·5, G = 2·71 (leuchtenbergite), both by Hermann, from the serpentine of Snarum, *i* by Hochstetter, *k* by Giwartowsky, *l* by Rammelsberg :—

	g	*h*	*i*	*k*	*l*
Silica	30·80	32·35	32·03	30·2	34·88
Alumina	17·27	18·00	12·52	13·2	12·48
Red oxide of iron . .	1·37	—	4·48	3·1	5·81
Protoxide of iron . .	—	4·37	—	—	—
Magnesia	37·08	32·29	37·52	37·9	34·02
Water	12·30	12·50	16·19	17·0	13·68

Analyses of the variety showing the combination *ol*, (pennine) *m*, *n* from Zermatt by Schweitzer, *o*, *p* from Zermatt, *q* from Binnenthal, all by Marignac, *r* of the violet variety called kämmererite by Hartwall :—

	m	*n*	*o*	*p*	*q*	*r*
Silica	33·82	33·07	33·36	33·40	33·95	37·0
Alumina	9·32	9·69	13·24	13·41	13·46	14·2
Red ox. iron . . .	—	—	5·93	5·73	6·12	Ca 1·5

	m	*n*	*o*	*p*	*q*	*r*
Oxide of chrome . .	—	—	0·20	0·15	0·24	1·0
Protox. iron	11·30	11·36	—	—	—	1·5
Magnesia	33·04	32·34	34·21	34·57	33·71	31·5
Water	11·50	12·58	12·80	12·74	12·52	13·0

In *o*, *p*, *q* part of the iron is in the state of protoxide.

In crystals and granular masses, in beds and veins in crystalline rocks.

Is found on the Schwarzenstein Alp in the Zillerthal in the Tyrol, in the valley of Ala in Piedmont, Achmatowsk near Slatousk in the Ural, Reichenstein in Silesia, Mauléon in the Pyrenees, in the neighbourhood of Arendal in Norway. Pennine is found in the Matterthal and Binnenthal in the Valais. Kämmererite occurs in six-sided prisms, and scaly granular masses, associated with chromite at Bissersk in Siberia. The rhodochrome from the island of Tino, Kyschtimsk in the Ural, Kraubat in Stiria, Baltimore in the United States, is supposed by Hausmann to be kämmererite.

The value of *ro* is obtained from the measurement of crystals from Achmatowsk by v. Kokscharow. He observed faces truncating the edge *ob* making with *o* the following angles: 60° 48′...60° 55′, 63° 10′, 65°, 66° 2′, 72° 30′, 78° 42′; faces truncating the edge *ob″* making with *o* the angles 61° 50′, 62° 30′, 69° 30′...69° 40′, 71° 50′, 72° 5′, 77° 25′...77° 30′, 77° 55′; and faces in the intermediate zone, making with *o* the angles 54° 45′, 55°, 66° 50′, 69° 50′, 71° 10′, 74° 5′, 76°, 76° 5′, 77° 50′, 78° 55′, 79°. In kämmererite v. Kokscharow observed faces making with *o* angles of 70° 52′...71° 2′, 84° 26′...84° 28′, 84° 44′, 86°. G. Rose observed faces making with *o* an angle of 75° 40′...75° 50′. According to Breithaupt faces occur making an angle of 43° 51′ with *o*.

261. CHLORITE. — Chlorite (in part); Phillips. Talc chlorite (in part); Hauy. Ripidolith; G. Rose, Rammelsberg. Prismatischer Talk-Glimmer (in part); Mohs. Chlorit; v. Kobell, Hausmann, Haidinger, Naumann, Dana.

Rhombohedral.

o 111.

ao	90°	0′
aa′	60	0
xo	53	25
xx′	47	20
vo	74	35

FIG. 429.

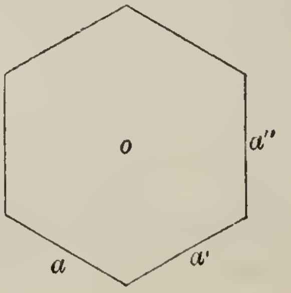
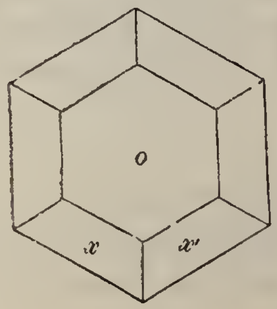


FIG. 430.



Combinations. *oa*, *ox*, *or*. Cleavage. *o*, very perfect. In thin plates transparent...translucent. Lustre on *o* pearly. Green of various shades, blue; frequently red in a direction parallel to *o*. Streak green, greenish-grey. In thin leaves flexible, not elastic. H = 1·0...1·5. G = 2·78...2·96.

In the matrass yields water. Fusible with difficulty on the thinnest edges before the blowpipe. With borax melts into a glass coloured by iron and sometimes by chrome. Is decomposed completely by concentrated sulphuric acid.

Analyses of chlorite *a* from the Greiner, *b* from the Zillerthal, *c* from Rauris, all by v. Kobell, *d* from St. Gotthardt by Varrentrapp, *e* from St. Christophe, *f* from Mont des Sept-Lacs, both by Marignac:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	26·51	27·32	26·06	25·37	26·88	27·14
Alumina	21·81	20·69	18·47	18·50	17·52	19·19
Magnesia	22·83	24·89	14·69	17·09	13·84	16·78
Protox. iron . . .	15·00	15·23	26·87	28·79	29·76	24·76
Protox. manganese .	—	0·47	0·62	—	—	—
Water	12·00	12·00	10·45	8·96	11·33	11·50
Not decomposed . .	—	—	2·24	—	—	—

Occurs in attached crystals, slaty, granular or earthy masses, pseudomorphous in the form of amphibole; as a constituent of some granite, gneiss, diabase, and especially of various slaty rocks.

Is found in the Ural, Norway, Sweden, Switzerland, the Zillerthal and the Greiner in the Tyrol, Salzburg, Berggiesshübel in Saxony, Cornwall, Arran, Bute.

262. LOGANITE.—Loganite; Hunt. Philosophical Magazine, July, 1851.

Prismatic.

a 100, *b* 010, *c* 001, *m* 110.

Cleavage. *c*, *m* distinct; *b*, imperfect. Fracture uneven. Subtranslucent. Lustre vitreous, shining on the cleavages; the surfaces of the crystals generally dull. Clove-brown... chocolate-brown. Streak greyish-white. H = 3·0. G = 2·60 ...2·64.

In the matrass yields water having an empyreumatic odour. Before the blowpipe loses colour and becomes greyish-white, but does not melt. Is partly decomposed by acids.

Analyses by T. S. Hunt:—

Silica	32·84	32·14	33·17
Alumina	13·37	13·00	—
Magnesia	35·12	36·43	—
Red oxide of iron	2·00	2·28	—
Water and $\ddot{C}$	17·02	16·83	16·50
Lime	0·96	0·93	—

Is found in short thick crystals having rounded edges, in white crystalline limestone mixed with pale green serpentine, at Calumet Island on the Ottawa in Canada.

263. DAMOURITE.—Damourite; Dufrénoy, Hausmann.

Cleavable. In thin plates transparent. Lustre pearly. Colourless, white, in thick pieces inclining to yellow. H = 2·0 ...3·0. G = 2·792.

Before the blowpipe intumesces, becomes white and opaque, shines brightly and melts with difficulty into a white enamel. With solution of cobalt becomes blue after being strongly ignited. Soluble in borax, imparting to it the colour of iron. Is decomposed by sulphuric acid; after ignition is not acted upon by sulphuric acid.

Mean of two analyses by Delesse:—

Silica	45·22
Alumina	37·85
Red oxide of iron	trace
Potash	11·20
Water	5·25

Is found in crystalline plates between crystals of kyanite at Pontivy in Bretagne.

264. EPHESITE. — Ephesite; J. L. Smith. Silliman's Journal, Jan. 1851.

Cleavage difficult. Lustre pearly. White. Scratches glass easily. G = 3·15...3·20.

Before the blowpipe becomes milk-white, but does not fuse.

Analysis by J. L. Smith:—

Silica	30·04
Alumina	56·45
Lime	2·11
Protoxide of iron	1·00
Soda with a little potash	4·41
Water	3·06

Is found on magnetite with the emery of Gumuch-dagh, near Ephesus.

265. ALLOPHANE.—Allophane; Phillips, Hauy. Lamprochromatischer Opalin-Allophan; Mohs. Allophan; Hausmann, Haidinger.

Fracture flat conchoidal...even...earthy. Semi-transparent ...translucent on the edges. Lustre waxy inclining to vitreous. White, yellow, red, brown, blue, green. Brittle. H = 3·0. G = 1·852...1·889.

Intumesces before the blowpipe. Infusible. With borax forms a colourless glass. Gelatinizes with acids.

Analyses of allophane *a* from Gräfenthal by Stromeyer, *b* from Gernsbach by Walchner, *c* from Fermi by Guillemin, *d* from Friesdorf by Bunsen, *e*, *f* from Beauvais by Berthier:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	21·92	24·11	23·76	21·05	21·9	26·3
Alumina	32·20	38·76	39·68	30·37	29·2	34·2
Water	41·30	35·75	35·74	40·23	44·2	38·0
Lime	0·73	—	$\dot{\mathrm{Ca}}\,\ddot{\mathrm{C}}$	2·39	—	—
Carb. ox. copper	3·06	$\dot{\mathrm{Cu}}$ 2·33	0·65	clay	4·7	1·5
Hydrate ox. iron	0·27	—	$\dddot{\mathrm{Fe}}$	2·74	—	—
Gypsum	0·52	—	$\dot{\mathrm{Mg}}\,\ddot{\mathrm{C}}$	0·06	—	—

Is found in reniform and botryoidal masses, and disseminated, near Gräfenthal in Saalfeld, Gernsbach in the Black Forest, Schapbach, Schneeberg in Saxony, Petrow in Moravia, Chottina in Bohemia, Miedziana-Gora, Friesdorf near Bonn.

266. SCHRÖTTERITE.—Schrötterit; Hausmann, Haidinger.

Amorphous.

Fracture flat conchoidal. Translucent...translucent on the edges. Lustre vitreous, inclining to waxy. Light emerald-green, ..greyish-green. Streak white. Brittle. H = 3·0... 3·5. G = 1·985...2·015.

Infusible. Gelatinizes with hydrochloric acid.

Analyses by Schrötter:—

Silica	11·95	11·93
Alumina	46·30	46·28
Water	36·20	35·50

Red oxide of iron	2·95	2·66
Oxide of copper	0·25	0·25
Lime	1·30	1·03
Sulphuric acid	0·78	0·48

Is found in nodules between granular limestone and clay slate on the Dollinger mountain near Freienstein in Styria.

267. MILOSCHINE.—Miloschin ; Hausmann, Haidinger.

Fracture conchoidal...earthy. Translucent on the edges... opaque. Glimmering...dull. Blue...green. Soft, meagre to the touch. H = 1·5...2·0. G = 2·131.

Falls to pieces in water. Infusible before the blowpipe. Soluble with difficulty in borax, yielding indications of chrome. Partially decomposed by hydrochloric acid.

$\dddot{Al}\ddot{Si} + \dot{H}^3$.

Analysis by Kersten :—

Silica	27·50
Alumina	45·01
Oxide of chrome	3·61
Lime	0·30
Magnesia	0·20
Water	23·30

Is found massive at Rudnjak in Servia.

268. WOLCHONSKOITE.—Wolchonskoit ; Mohs, Hausmann, Haidinger.

Fracture conchoidal. Opaque. Dull. Green. Streak green, lighter, shining. H = 2·0...2·5. G = 2·213...2·303.

Infusible before the blowpipe. With fluxes yields the reaction of chrome and silica. Gelatinizes with hydrochloric acid.

Analyses *a* by Berthier, *b* by Kersten, *c* by Ilimhoff :—

	a	*b*	*c*
Silica	27·2	37·01	30·06
Alumina	—	6·47	3·09
Oxide of chrome	34·0	17·93	31·24
Red oxide of iron . . .	7·2	10·48	9·39
Oxide of manganese .	—	1·66	$\dot{Ca}$ 1·90
Oxide of lead	—	1·01	0·16
Magnesia	7·2	1·91	6·50
Water	23·2	21·84	12·40

Is found in veins and nodules in the circle of Ochansk in the government of Perm in Russia.

269. MEERSCHAUM. — Earthy carbonate of magnesia; Phillips. Magnésie carbonatée silicifère spongieuse; Hauy. Meerschaum; Mohs, Hausmann, Haidinger.

Fracture earthy. Opaque. Dull. White, inclining to yellow, red or grey. Streak shining. Adheres to the tongue. H = 2·5. G = 1·2…1·6.

In the matrass yields water and turns black. Before the blowpipe melts on the edges. With solution of cobalt becomes red. Is decomposed by hydrochloric acid.

Analyses of meerschaum *a* from the Levant by Lychnell, *b* from Cavañas, *c* from Coulommiers, both by Berthier, *d* from Langbanshytta, mean of two, by Berlin, *e* from Thebes in Greece by v. Kobell, *f* from Morocco by Damour:—

	a	*b*	*c*	*d´*	*e*	*f*
Silica	60·87	53·8	54·0	51·57	48·00	55·00
Magnesia	27·80	23·8	24·0	33·90	20·06	28·00
Lime	—	—	—	—	—	1·01
Red oxide of iron . .	0·09	—	—	0·57	12·40	1·40
Alumina	—	1·2	1·4	0·16	—	1·20
Protox. mangan. . .	—	—	—	1·56	potash	0·52
Water	11·29	20·0	20·0	11·83	19·60	10·35
Sand	—	—	—	—	—	1·50

Is found in nodules at Kiltschiek near Konie in Natolia, near Thebes and in many other parts of Greece, Vallecas near Madrid and Cavañas near Toledo, Pinheiro in Portugal, Hrubschitz and Oslowan in Moravia, Sweden.

270. PALAGONITE. — Palagonit; Sartorius v. Waltershausen, Hausmann.

Amorphous. Fracture conchoidal, uneven, splintery. Transparent…translucent. Lustre that of varnish, waxy, vitreous. Yellow, brown; sometimes brown by reflected, yellow by transmitted light. Streak ochre yellow. Brittle. H = 3·0…4·5. G = 2·40…2·43.

In the matrass yields water and becomes cinnamon-brown, afterwards blackish-brown. Melts easily before the blowpipe into a bright, black, magnetic globule. With fluxes yields the reactions of iron and traces of those of manganese. Is readily decomposed by hydrochloric acid leaving a residue of silica.

Analyses of palagonite *a* from Trollkonugil near Hecla, *b* from Laugarvatnshellir, *c*, *d* from the Galapagos, all by Bunsen:—

	a	b	c	d
Silica	39·98	40·38	37·83	36·15
Alumina	8·26	10·79	12·95	11·31
Protoxide of iron	17·65	13·52	9·93	10·48
Lime	8·48	8·56	7·49	7·78
Magnesia	4·45	6·35	6·54	6·14
Potash	0·43	0·64	0·94	0·76
Soda	0·61	0·61	0·70	0·54
Water	18·25	16·98	23·00	24·69
Insoluble	1·89	2·32	0·96	2·19

Is found massive and disseminated as an ingredient of the volcanic tufa in the neighbourhood of Palagonia in the Val di Noto in Sicily, and in Iceland, especially at Seljadlr half way between Reykiavik and Thingvellir.

271. GROPPITE.—Groppit; Svanberg, Hausmann.

Has one distinct cleavage, and two cleavages less distinct. Fracture splintery. In thin fragments semi-transparent. Rose-red…brown-red. Streak light. Brittle. H = 2·5. G = 2·73.

In the matrass yields water. Before the blowpipe becomes white and melts on the edges. Easily soluble with effervescence in borax.

Analyses by Svanberg:—

Silica	45·01
Alumina	22·55
Red oxide of iron	3·06
Magnesia	12·28
Lime	4·55
Potash	5·23
Soda	0·22
Water	7·11
Undecomposed mineral	0·13

Is found in crystalline cleavable masses in the limestone quarry of Gropptrop in the parish of Wingaker in Södermanland in Sweden.

272. CHLOROPAL.—Chloropal; Mohs, Hausmann, Haidinger.

Fracture conchoidal…earthy. Opaque…translucent on the edges. Lustre vitreous, dull. Brittle. H = 3·0…4·0. G = 2·0.

Becomes black and magnetic before the blowpipe, but does not melt. With fluxes yields the reaction of iron.

Analyses *a*, *b* by Brandes, *c* by Biewend:—

	a	*b*	*c*
Silica	46·0	45·00	41·10
Red oxide of iron	35·3	32·00	37·30
Magnesia	2·0	2·00	—
Alumina	1·0	0·75	—
Water	18·0	20·00	21·56

Is found massive and disseminated at Unghwar in Hungary, and at Andreasberg in the Harz.

273. **DILLNITE.**—Dillnit; Hutzelmann.

Fracture flat conchoidal, even, earthy. Opaque. Dull. White. H = 3·5. G = 2·835, of the earthy variety 1·8...2·0.

Analyses of dillnite from Schemnitz *a* compact, by Hutzelmann, *b* earthy, by Karafiat:—

	a	*b*
Silica	22·40	23·53
Alumina	56·40	53·00
Lime	trace	0·88
Magnesia	0·44	1·76
Water	21·13	20·05

Is found in irregular veins at the junction of the diorite and limestone in the Dilln mine at Schemnitz in Hungary.

274. **PECTOLITE.**—Pectolite; Beudant. Pektolith; Mohs, Hausmann, Haidinger.

Translucent on the edges. Lustre pearly. Greyish-white. Brittle. H = 4·0...5·0. G = 2·745...2·756.

In the matrass yields water. Before the blowpipe melts easily into a white bead. In powder is decomposed by hydrochloric acid, leaving a flocky residue of silica. After ignition forms a jelly with hydrochloric acid.

Analyses of pectolite *a* from Monte Baldo by v. Kobell, *b*, *c* from the Isle Royale by Whitney, *d* from Bergen Hill (stellite) by Kendall, *e* from Bergen Hill by Dickinson, *f* (osmelite) by Adam:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	51·30	53·45	55·66	54·00	55·00	52·91
Lime	33·77	31·21	32·86	32·10	32·53	32·96
Protox. mangan.	—	—	—	1·90	1·10	0·32
Soda	8·26	7·37	7·31	8·89	9·72	6·10

	a	*b*	*c*	*d*	*e*	*f*
Potash	1·57	trace	—	—	—	2·79
Alumina	0·90	4·94	1·45	—	—	0·54
Water	3·89	2·72	2·72	2·96	2·75	4·01

The variety from Monzoni contains fluorine; part of the silica in *b*, *c*, as well as the alumina in *c*, appears to have been in the state of a mechanical mixture.

Is found in spherical masses, consisting of delicate silky fibres radiating from a centre, with mesotype in amygdaloid on Monte Baldo in Verona, in felspar on the Monzoni mountain in Fassathal in the Tyrol, Isle Royale in Lake Superior. The variety called stellite is found on Bergen Hill in New Jersey, and near Kilsyth in Scotland. Osmelite is found at Wolfstein in Rhenish Bavaria.

275. GYROLITE. — Gurolite. Anderson. Philosophical Magazine, February, 1851.

Cleavage in one direction, easily obtained. Lustre vitreous, passing into pearly when it has been exposed to the weather. In thin plates perfectly transparent. White. Very tough. H = 3·0...4·0.

In the matrass yields water, intumesces and separates into thin plates, which have a pearly or silvery lustre. On charcoal before the blowpipe swells up, splits into very thin laminæ, and fuses with difficulty into an opaque enamel. With borax yields a transparent colourless glass. With soda fuses with difficulty into an opaque mass.

$\dot{\mathrm{Ca}}^2\ddot{\mathrm{Si}}^3 + \dot{\mathrm{H}}^3$.

Analysis by Dr. T. Anderson:—

Silica	50·70
Alumina	1·48
Lime	33·24
Magnesia	0·18
Water	14·18

Occurs in small spherical concretions composed of thin plates radiating from a centre, in the drusy cavities of an extremely compact basalt, at Storr about nine miles from Portree in Skye.

276. APOPHYLLITE. — Apophyllite; Phillips, Hauy. Pyramidaler Kuphon-Spath; Mohs. Apophyllit; Hausmann, Haidinger.

Pyramidal. 101,001 = 51° 21′.

c 001, *a* 100, *m* 110, *r* 210, *s* 102, *v* 105, *p* 111, *z* 113, *d* 115.

ac	90°	0′	*dc*	19°	30′	*pp″*	121°	4′
aa′	90	0	*pp′*	76	0	*rr′*	36	52
ma	45	0						
ra	26	34						
sc	32	2						
sa	57	58						
vc	14	3						
va	75	57						
pc	60	32						
zc	30	32						

FIG. 431.

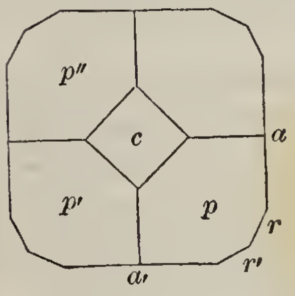
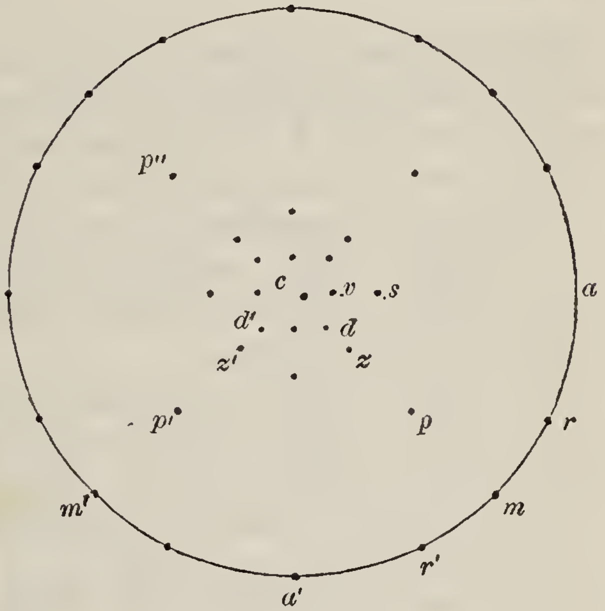


FIG. 432.



Combinations. *pa, ac, cpa, par, pma, pcar, pamr, cvdzspar.* The faces *c* smooth, bright and even, sometimes faintly striated parallel to their intersections with *p*; *p*, smooth, sometimes curved; *a, m,* especially *a*, striated parallel to their intersections with each other; *r*, usually curved, not so bright as *a*; *d*, striated parallel to their intersection with *c*. Cleavage. *c*, very perfect; *a*, imperfect. Fracture imperfect conchoidal or uneven. Transparent...faintly translucent. Lustre vitreous, *c*, pearly. R = 1·543. Colourless, white inclining to grey, yellow, blue, red, green. Streak white. Brittle. H = 4·5...5·0. G = 2·35...2·39.

In the matrass yields water. In the open tube many varieties afford the reaction of fluorine. Exfoliates before the blowpipe, and melts with intumescence into a white blebby enamel. In powder is easily decomposed by hydrochloric acid, leaving silica in powder. After ignition it is decomposed with difficulty by acids. According to Wöhler, soluble in water at 180°...190° C, under a pressure of from 10 to 12 atmospheres, and crystallizes on cooling.

Analyses of apophyllite *a* from Faröe, *b* from Utö, both by

Berzelius, *c*, *d* from Andreasberg, *e* from Radauthal in the Harz, G = 1·961, all by Rammelsberg:—

	a	*b*	*c*	*d*	*e*
Silica	52·38	52·13	51·33	50·20	52·44
Lime	24·70	24·43	25·86	24·52	24·61
Potash	5·37	5·27	4·90	not det.	4·75
Water	16·20	16·20	—		16·73
Fluorine	1·20	1·54	1·28	1·09	—
$\dot{\mathrm{C}}\mathrm{a}\bar{\mathrm{S}} + 3\mathrm{CaFl}$ . . .	—	—	—	—	1·43

The 1·43 parts of $\dot{\mathrm{C}}\mathrm{a}\bar{\mathrm{S}} + 3\mathrm{CaFl}$ in analysis *e* consist of calcium 0·65, silicon 0·12, fluorine 0·46, oxygen 0·20. In 100 parts of apophyllite from Utö, Rammelsberg found silica 48·94, fluorine 0·74, in one instance, and silica 52·29, fluorine 0·24 in another.

In attached crystals and massive, usually in the cavities of amygdaloidal rocks, sometimes in veins in transition slate with ores of silver and lead, and in beds of magnetite and copper pyrites and other ores.

Is found at Cziklowa in the Banat, the Seisser Alp and some other places in the Tyrol, Iceland and the Faröe islands, Andreasberg and Radauthal in the Harz, Poonah in Hindostan, Marienberg near Aussig, Güntersdorf, Daubitz and other places in Bohemia, Utö and Hällesta in Sweden, Disko, Greenland, North America, in Fifeshire, Nertschinsk in Siberia.

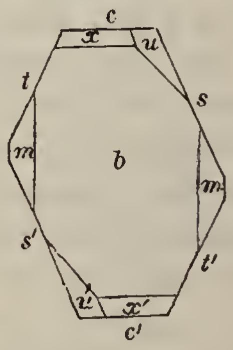
277. HEULANDITE.—Heulandite; Phillips, Beudant. Hemiprismatischer Kuphon-Spath; Mohs. Stilbit; Hausmann. Heulandit; Haidinger.

Oblique. 101,100=43° 53′; 111,010=73° 27′·5; 101,001=47° 32′.

a 100, *b* 010, *c* 001, *x* 011, *s* 201, *t* $\bar{2}$01, *m* 110, *u* 111.

cb	90°	0′
sb	90	0
sc	66	0
tc	63	40
xb	49	20
ub	73	28
mb	68	2

FIG. 433.



Combinations. *cstb*, *custmb*, *custmxb*. Cleavage. *b*, very perfect. Fracture uneven...imperfect conchoidal. Transparent

...translucent on the edges. Lustre vitreous, on *b* pearly. Colourless, white passing into grey, brown, red. Streak white. Brittle. H = 3·5...4·0. G = 2·18...2·22.

In the matrass yields water. Exfoliates before the blowpipe, intumesces and melts into a white enamel. Is easily decomposed by hydrochloric acid, leaving silica in powder.

$\dot{C}a\ddot{S}^3 + \dddot{A}l\ddot{S}i^3 + \dot{H}^5$, silica 59·79, alumina 16·59, lime 9·06, water 14·56.

Analyses of heulandite *a* by Walmstedt, from the Faröe islands *b* by Thomson, from Iceland *c* by Rammelsberg, *d*, *e* by Damour:—

	a	*b*	*c*	*d*	*e*
Silica	60·07	59·15	58·2	59·64	60·07
Alumina	17·08	17·92	17·6	16·33	15·96
Red oxide of iron . .	0·20	—	—	—	—
Lime	7·13	7·65	7·2	7·44	7·67
Soda	—	—	—	1·16	1·15
Potash	—	—	—	0·74	0·60
Water	15·10	15·40	16·0	14·33	14·33

In attached crystals, laminar or granular masses, usually in cavities of amygdaloidal rocks with stilbite, and other zeolites, less frequently in beds of magnetite and veins of silver ores, in slate rocks.

Is found at Ostfiord in Iceland, the Faröe islands, the Vendayah mountains in Hindostan, Cape Blomidon in Nova Scotia, Kossakow near Gabel in Bohemia, Fassathal in the Tyrol, near Suppapiatre in Transylvania, Arendal and Tellemarken in Norway, Andreasberg in the Harz, near Zwickau, Dresden and Grünstädel in Saxony, at Nertschinsk and Werchneyudinsk on the Schilka in Siberia, Campsie near Dumbarton in Scotland, the island of Skye.

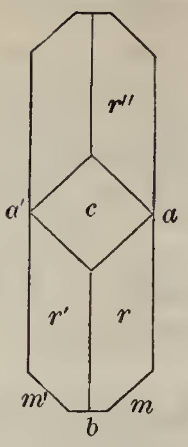
According to Breithaupt, heulandite belongs to the anorthic system.

278. STILBITE.—Stilbite; Phillips, Beudant. Prismatoidischer Kuphon-Spath; Mohs. Desmin; Hausmann. Stilbit; Haidinger.

Prismatic. 011,010=50° 52′; 101,001=37° 4′; 110,100=47° 7′·5.

a 100, *b* 010, *c* 001, *e* 011 twin-face, *m* 110, *r* 111.

FIG. 434.



bc	90° 0′		*ra*	59° 38′	
ca	90 0		*rb*	57 0	
ab	90 0		*rc*	48 0	
eb	50 52		*rr′*	60 44	
ma	47 8		*rr″*	66 0	
mm′	85 44				

Combinations. *rab*, *crab*, *crmab*. The faces *c* sometimes curved; *a*, *b* striated parallel to their intersection with each other; *r*, rough. Twins. Twin-face *e*. Cleavage. *a*, very perfect; *b*, traces. Fracture uneven. Semi-transparent...translucent. Lustre vitreous; on *a* pearly. Colourless, white, yellow, red, brown. Streak white. Brittle. H = 3·5...4·0. G = 2·1...2·2.

In the matrass yields water. Phosphoresces before the blowpipe, and melts into a blebby glass. Is completely decomposed by acids, leaving the silica in the state of a slimy powder.

$\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{S}}\mathrm{i}^3 + \dddot{\mathrm{A}}\mathrm{l}\ddot{\mathrm{S}}^3 + \dot{\mathrm{H}}^6$, silica 58·09, alumina 16·12, lime 8·81.

Analyses of stilbite *a* from Naalsöe by Retzius, *b* by Meyer, from Iceland *c* by Hisinger, *d* by Fuchs and Gehlen, *e*, *f* from the Rienthal in Uri by G. Leonhard:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	56·08	58·3	58·0	55·07	56·50	55·00
Alumina	17·22	17·5	16·1	16·58	18·50	18·50
Lime	6·95	6·6	9·2	7·58	8·18	7·91
Soda	2·17	—	$\dot{\mathrm{N}}\mathrm{a}$,$\dot{\mathrm{K}}$	1·50	~~$\bar{\mathrm{F}}\mathrm{e}$~~	0·02
Water	18·35	17·5	16·4	19·30	17·00	17·00

Analyses of stilbite *g*, *h* from the Faröe islands by Moss, *i* from the Pangelberg near Nimptsch in Silesia by Zellner, *k* from the Faröe islands, G = 2·17, by Delesse, *l* from the Ilmen mountains, G = 2·19, by Hermann:—

	g	*h*	*i*	*k*	*l*
Silica	56·93	57·18	60·27	55·0	56·31
Alumina	16·54	16·44	14·43	16·7	16·25
Lime	7·55	7·74	6·40	6·5	7·66
Potash	0·20	0·32	$\dot{\mathrm{M}}\mathrm{g}$ 0·21	$\dot{\mathrm{F}}\mathrm{e}$,$\dot{\mathrm{M}}\mathrm{n}$	1·00
Soda	1·54	1·11	(loss	3·0)	1·03
Water	17·79	17·79	18·50	18·8	17·75

Analyses of stilbite *m*, *n* from Niederkirchen in Rhenish Bavaria by Riegel, *o* from the neighbourhood of Christiania, G = 2·203, by Münster, *p* from Gustavsberg in Jemtland, *q* from the Barbro mine in Norway, both by Sjögren:—

	m	*n*	*o*	*p*	*q*
Silica	58·33	58·40	58·53	57·41	58·41
Alumina	16·66	17·15	15·73	16·14	16·56
Lime	7·16	6·80	7·02	8·75	7·89
Red ox. iron	0·26	0·20	0·50	0·25	—
Soda	1·62	1·62	Ṅa,Ṁg 3·07	Ṅa,Ṁg,Ṁn	0·54
Water	14·50	14·50	17·05	16·60	16·53

In attached crystals and massive, chiefly in the cavities of amygdaloidal rocks, with other zeolites and calcite; less frequently in beds, veins and cavities, in granite, gneiss, mica slate, hornblende slate, clay slate.

Is found in Iceland, the Faröe islands, the islands of Skye and Arran, Indore in the Vendayah mountains in Hindostan, in the Fassathal in the Tyrol, Kongsberg and Arendal in Norway, Gustavsberg in Jemthal in Sweden, Pangelberg near Nimptsch in Silesia, the valley of Gastein in Salzburg, Cziklowa in the Banat, Andreasberg in the Harz, St. Gotthardt and many other places in the Alps, St. Christophe in Dauphiné, Kilpatrick in Dumbartonshire, Kilmalcolm in Renfrewshire, Nertschinsk in Siberia, Nova Scotia, Baltimore.

279. EPISTILBITE.—Epistilbite; Phillips, Beudant. Diplogener Kuphon-Spath. Mohs. Epistilbit; Hausmann, Haidinger.

Prismatic. 011,010=54° 53′; 101,001=16° 10′; 110,100=67° 35′.

a 100, *t* 011, *s* 101, *m* 110, *u* 211.

tt′	70°	14′
ss′	32	20
sa	73	50
ma	67	35
mm′	44	50
st	38	13
sm	83	54
tm	57	51
ua	64	37
ut	25	23
uu″	62	37
u′u″	84	42

FIG. 435.

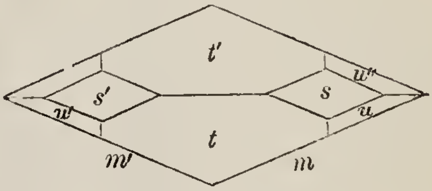
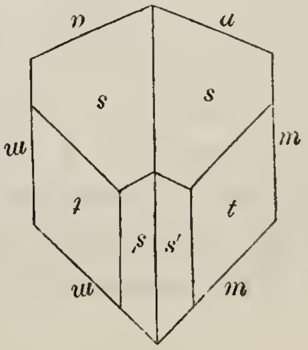


FIG. 436.



Combinations. *stm*, *astm*, *stmu*. The faces *s*, dull; *t*, *a* even; *m*, smooth but uneven. Twins. Twin-face *m*. *av* = 44° 50′. *mu* = 90° 20′. *ss* = 22° 12′. *tz* = 64° 18′. Cleavage. *a*, very distinct. Fracture uneven. Transparent...translucent on the edges. Lustre vitreous; *a*, pearly. Colourless, white. Streak white. Brittle. H = 3·5...4·0. G = 2·24...2·25.

In the matrass yields water. Before the blowpipe melts with intumescence into a blebby enamel. Is decomposed by concentrated hydrochloric acid, leaving silica in powder. After ignition it cannot be decomposed by acids.

$\dot{Ca}\ddot{Si}^3 + \dddot{Al}\ddot{Si}^3 + \dot{H}^5$, silica 59·79, alumina 16·59, lime 9·06, water 14·56, a small portion of the lime being replaced by soda.

Analyses *a*, *b* by G. Rose, *c* by Beudant:—

	a	*b*	*c*
Silica	58·59	60·28	58·61
Alumina	17·52	17·36	17·03
Lime	7·56	8·32	8·21
Soda	1·78	1·52	1·20
Water	14·48	12·52	13·80

In attached crystals and massive, with heulandite, in the cavities of amygdaloidal rocks in Iceland and the Faröe islands. It is said to occur also in the basalt of the Siebengebirge on the Rhine, and on Rathlin and at Portrush in Ireland.

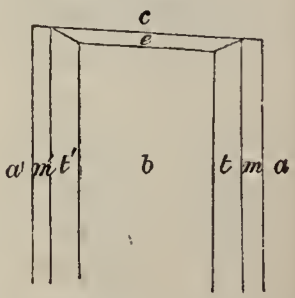
280. BREWSTERITE.—Brewsterite; Phillips, Beudant. Megalogoner Kuphon-Spath; Mohs. Brewsterit; Hausmann, Haidinger.

Oblique.

a 100, *b* 010, *c* 001, *m* 110, *t* 120.

cb	90°	0′
ac	86	20
ab	90	0
mb	68	0
tb	51	4
mm′	136	0

FIG. 437.



The faces *m*, *t* striated parallel to their intersections with each other. Cleavage. *b*, perfect; *a*, traces. Fracture uneven. Brittle. H = 5·0...5·5. G = 2·12...2·20.

In the matrass yields water and becomes opaque. Intumesces before the blowpipe, and fuses with difficulty. Is decomposed by hydrochloric acid, leaving a residue of silica.

Analyses by Connel and Thomson :—

Silica	53·67	53·05
Alumina	17·49	16·54
Red oxide of iron . . .	0·29	—
Strontia	8·33	9·01
Barytes	6·75	6·05
Lime	1·35	0·80
Water	12·58	14·74

Is found in attached crystals, in veins at Strontian in Argyleshire, coating the cavities in amygdaloidal rocks at the Giant's Causeway, and in the lead mines of St. Turpet near Freiburg in the Breisgau. It is said to occur also in the department of Isère in France and in the Pyrenees.

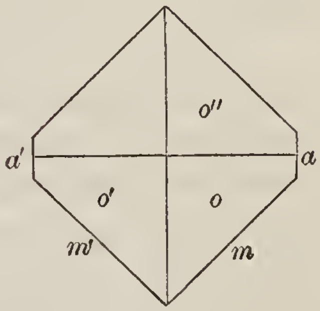
281. MESOTYPE.—Mesotype; Phillips, Hauy. Prismatischer Kuphon-Spath; Mohs. Zéolith; Hausmann. Natrolith; Haidinger.

Prismatic. 011,010=70° 17′·5; 101,001=19° 24′; 110,100=45° 30′.

a 100, *m* 110, *o* 111.

ma	45°	30′
mm′	89	0
oa	71	40
oo′	36	40
oo″	37	20
o′o″	53	20
om	63	20

FIG. 438.



Combinations. *om*, *oma*. *a*, striated parallel to its intersection with *m*; *o*, sometimes curved. Cleavage. *m*, perfect. Fracture conchoidal, uneven. Transparent...translucent. Lustre vitreous. Colourless, grey, yellow, sometimes red, pale green. Streak white. Brittle. H = 5·0...5·5. G = 2·24...2·26.

In the matrass yields water. Melts quietly and without intumescence before the blowpipe into a clear glass. Is decomposed by hydrochloric acid, leaving a jelly of silica. Almost entirely soluble in oxalic acid, forming a jelly of silica.

$\dot{Na}\ddot{Si} + \dddot{Al}\ddot{Si}^2 + \dot{H}$, silica 47·96, alumina 26·62, soda 16·08, water 9·34. Sometimes a portion of the soda is replaced by lime.

Analyses of mesotype *a* from Högau by Klaproth, *b* from Högau, *c*, *d* from Auvergne, *e* from the Tyrol, massive, all by Fuchs, *f* from Antrim by Thomson:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	48·00	47·21	47·76	48·17	48·63	47·56
Alumina	24·25	25·60	25·88	26·51	24·82	26·42
Red ox. iron . . .	1·75	1·35	—	—	0·21	0·58
Lime	—	—	—	0·17	—	1·40
Soda	16·50	16·12	16·21	16·12	15·69	14·93
Water	9·00	8·88	9·31	9·17	9·60	10·44

Analyses of mesotype *g* from Greenland, massive, by v. Kobell, *h* from Iceland, fibrous, by Sander, *i* red, *k* white (bergmannite) from the zircon-syenite of the south of Norway, *l* (radiolite), all by Scheerer, *m* from the Högau by Riegel, *n* from Laurvig by C. Gmelin:—

	g	*h*	*i*	*k*	*l*	*m*	*n*
Silica . . .	46·94	47·34	47·97	48·12	48·38	48·05	48·68
Alumina . .	27·00	27·21	26·66	26·96	26·42	25·80	26·37
Red ox. iron	—	—	0·73	0·22	0·24	2·10	—
Lime . . .	1·80	1·34	0·68	0·69	0·44	—	—
Soda . . .	14·70	14·61	14·07	14·23	13·87	15·75	16·00
Potash . .	—	—	traces	traces	1·54	—	0·23
Water . .	9·60	9·47	9·77	10·48	9·42	9·00	9·55

In attached crystals and fibrous masses, in cavities in basalt, phonolite, &c.; sometimes in syenite, and in beds and veins in crystalline slate and transition rocks.

Is found in Auvergne, Greenland, Iceland, in the basalt of the Alpstein near Sontra in Hessia, at Marienberg and Wesseln near Ausig, and other places in Bohemia, Fassathal in the Tyrol, Hoentwiel in Högau in Würtemberg, Montecchio Maggiore in the Vicentine, in the trap rocks of the Giant's Causeway and the Hebrides, on the Rhine, near Göttingen and Münden, in zircon-syenite near Laurvig, Friedrichswärn and Brevig, and in beds of magnetite near Arendal in Norway.

It appears probable, from the researches of G. Rose, that the substances which have been called mesolite, from Hauenstein and Fassathal, not being pyroelectric, are varieties of mesotype.

Analyses of mesolite *a* from Hauenstein by Freismuth, *b* from Fassathal by Fuchs and Gehlen:—

	a	*b*
Silica	44·56	46·04
Alumina	27·56	27·00
Lime	7·09	9·61
Soda	7·69	5·20
Water	14·13	12·36

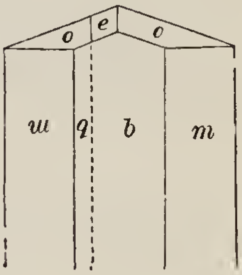
282. SCOLEZITE. — Needlestone; Phillips. Scolezite; Beudant. Harmophaner Kuphon-Spath; Mohs. Skolezit; Hausmann, Haidinger.

Oblique. 101,100 = 69° 59′; 111,010 = 72° 20′; 101,001 = 19° 7′.

a 100 twin-face, *b* 010, *m* 110, *o* 111, *e* 1̄11.

ab	90°	0′	*om*	63°	33′
mb	45	48	*em*	64	36
ob	72	20	*oa*	70	58
eb	72	10	*ea*	107	30
eo	36	32			

FIG. 439.



Combination. *oemb*. Twins. Twin-face *a*. Cleavage. *m*, perfect. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous, inclining to pearly. Colourless, white, greyish, reddish and yellowish white. Brittle. H = 5·0...5·5. G = 2·2...2·3. Pyroelectric, the antilogous poles being at the exposed ends of the attached crystals.

In the matrass yields water. Before the blowpipe curls up and then melts into a blebby glass. Is completely decomposed by hydrochloric acid, leaving a jelly of silica. Is partially soluble in oxalic acid, leaving a residue of oxalate of lime.

$\dot{Ca}\ddot{Si} + \dddot{Al}\ddot{Si}^2 + \dot{H}^3$, silica 46·50, alumina 25·81, lime 14·10, water 13·59.

Analyses of scolezite *a* from Iceland, *b* from Faröe, *c* from Staffa, fibrous, all by Fuchs and Gehlen, *d* from Auvergne by Guillemin, *e* from Iceland by v. Gülich:—

	a	*b*	*c*	*d*	*e*
Silica	48·94	46·19	46·75	49·0	46·76
Alumina	25·99	25·88	24·82	26·5	26·22
Lime	10·44	13·86	14·20	15·3	13·68
Soda	—	0·48	0·39	—	—
Water	13·90	13·62	13·64	9·0	13·94

Analyses of scolezite *f*, *g* from Niederkirchen in Rhenish Bavaria, both by Riegel, *h* from Iceland by Gibbs, *i* from the porphyry of the Cachapual valley in Chile by Domeyko:—

	f	*g*	*h*	*i*
Silica	48·16	48·00	46·72	46·3
Alumina	23·50	24·36	25·90	26·9
Lime	14·50	13·95	13·71	13·4
Soda	0·30	0·35	—	—
Water	13·50	13·60	13·67	14·0

In twin crystals, and masses, composed of radiating fibres, in cavities of amygdaloid, basalt, &c.

Is found in Staffa, the Faröe islands, Iceland, Greenland, the Vendayah mountains in Hindostan, the Tyrol, Ireland.

Mesolite from Iceland and from the Faröe islands is pyroelectric, and is, therefore, probably scolezite.

Analyses of mesolite *a*, *b* from Iceland, *c* from the Faröe islands by Fuchs and Gehlen, *d* from the Faröe islands by Berzelius:—

	a	*b*	*c*	*d*
Silica	46·78	47·46	47·00	46·80
Alumina	25·66	25·35	26·13	26·50
Lime	10·06	10·04	9·35	9·87
Soda	4·79	4·87	5·47	5·40
Water	12·31	12·41	12·25	12·30

Poonahlite is probably a variety either of scolezite or mesotype. It occurs in prisms of 87° 40′. The other characters are the same as those of scolezite. According to C. Gmelin, it consists of silica 45·12, alumina 30·45, lime 10·20, soda with a trace of potash 0·66, water 13·99. Is found with apophyllite at Poonah in the East Indies.

283. ANALCIME.—Analcime; Phillips, Hauy. Hexaedrischer Kuphon-Spath; Mohs. Analcim; Hausmann. Analzim; Haidinger.

Cubic.

a 100, *n* 211.

aa′	90°	0′
nn′	33	33
nn,	48	11
na	35	16
na′	65	54

FIG. 440.

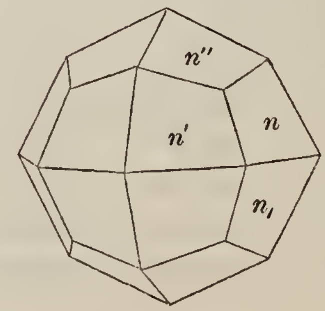
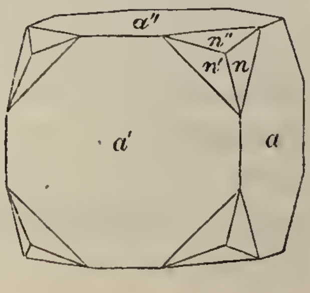


FIG. 441.



Form and combination. *n*, *an*. Cleavage. *a*, very imperfect. Fracture uneven, imperfect conchoidal. Translucent... translucent on the edges. Lustre vitreous, occasionally pearly. Colourless, white...grey, reddish-white...flesh-red. Streak white. Brittle. H = 5·5. G = 2·22...2·28.

In the matrass yields water and becomes white. Fuses before the blowpipe, without intumescence, into a clear glass. In powder is completely decomposed by hydrochloric acid, forming a jelly of silica.

$\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{S}}\mathrm{i} + \dddot{\mathrm{A}}\mathrm{l}\ddot{\mathrm{S}}\mathrm{i}^3 + \dot{\mathrm{H}}^2$, silica 55·13, alumina 22·95, soda 13·86, water 8·06.

Analyses of analcime *a* from Catania, *b* from Fassathal, both by H. Rose, *c* from Old Kilpatrick by Connel, *d* from the Giant's Causeway by Thomson, *e* from Lön-Oen near Brevig by Awdejew, *f* from Blagodat, G = 2·24...2·28, (cuboit) by Henry, *g* from Niederkirchen, mean of two analyses, by Riegel:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Silica . . .	55·12	56·47	55·07	55·60	55·16	57·34	56·81
Alumina . .	22·99	21·98	22·23	23·00	23·55	22·58	23·58
Red ox. iron .	—	—	—	—	—	—	0·12
Soda . . .	13·53	13·78	13·71	14·65	14·23	11·86	6·45
Potash . .	—	—	—	—	traces	0·55	—
Lime . . .	—	—	—	—	traces	0·35	5·72
Water . .	8·27	8·81	8·22	7·90	8·26	9·00	8·00

In crystals, and massive, usually in cavities in amygdaloidal rocks, basalt, &c.; less frequently in zircon-syenite, in beds of magnetite, in gneiss, porphyry, and in metallic veins.

Is found on the Seisser Alp and Fassathal in the Tyrol, Dumbarton, Glen-Farg and other places in Scotland, the Giant's Causeway in Ireland, the neighbourhood of Almas and Tökerö in Transylvania, near Aussig in Bohemia, the Vicentine, Monte Somma, Blagodat in the Ural, the Faröe islands, Iceland, several of the Hebrides, the Cyclopean islands; in beds of iron ore at Arendal in Norway, and in veins of silver ores at Andreasberg in the Harz.

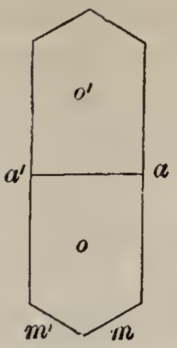
284. EUDNOPHITE.—Eudnophit; Weibye.

Prismatic.

a 100, *b* 010 cleavage, *c* 001 cleavage, *o* 011, *m* 110.

mm′	60°
ma	60
om	50

FIG. 442.



Cleavage. *c*, perfect; *a*, *b* less perfect. Fracture even, splintery. Transparent...translucent on the edges. Lustre on the surfaces of cleavage pearly. White...grey...brown. Streak white. H = 5·5. G = 2·27.

Melts before the blowpipe into a transparent, colourless glass. In powder is decomposed by hydrochloric acid, forming a jelly of silica.

Analyses *a* by v. Borck, *b* by Berlin:—

	a	*b*
Silica	54·93	55·06
Alumina	25·59	23·12
Soda	14·06	14·06
Water	8·29	8·16

This agrees with the composition of analcime, the substance of which is therefore dimorphous.

Is found in a coarse-grained syenite, with leucophane, mosandrite, &c., in the island of Lamö near Brevig.

285. CHABASIE.—Chabasie; Phillips, Hauy. Rhomboedrischer Kuphon-Spath; Mohs. Chabacit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 50° 45′.

o 111 twin-face, *a* 01$\bar{1}$, *e* 011, *r* 100, *s* $\bar{1}$11, *t* 021.

ao	90°	0′	*ee′*	54°	47′	*ae″*	62°	37′
aa′	60	0	*ss′*	107	8	*as″*	36	26
ra	90	0	*re*	83	32	*te*	17	52
rr′	85	14	*sr*	119	42	*tr′*	24	45
ea	90	0	*ar′*	47	23			

FIG. 443.

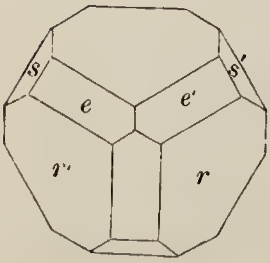


FIG. 444.

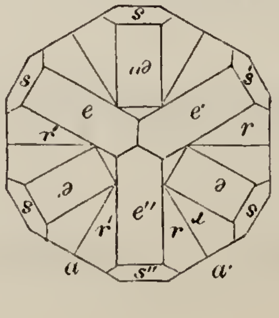
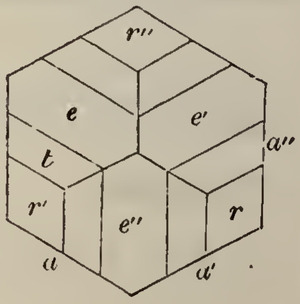


FIG. 445.



Form and combinations. *r*, *er*, *ers*, *ersa*. *eɹsta* (phacolite). The faces *e*, *r* striated parallel to their intersections with each other; *a*, striated parallel to the intersections with *r*. Twins. Twin-face *o*. *eə* = 64° 11′, *rɹ* = 102° 54′, *ss* = 136° 32′. The crystals of the variety called phacolite consist of four individuals, of the combination *asret*, two of which compose a twin, twin-face *o*, each being united to one of the remaining two individuals according to the same law. Cleavage. *r*, tolerably perfect. Fracture uneven. Semi-transparent...translucent. Colourless, white, sometimes reddish, yellowish. Streak white. H = 4·0...4·5. G = 2·08...2·15.

In the matrass yields water. Melts easily before the blowpipe into a spongy white enamel. Is completely decomposed by hydrochloric acid, leaving a jelly of silica.

$\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{S}}\mathrm{i} + \dddot{\mathrm{A}}\mathrm{l}\ddot{\mathrm{S}}\mathrm{i}^3 + \dot{\mathrm{H}}^6$, silica 48·03, alumina 19·99, lime 10·92, water 21·06.

Analyses of chabasie from Kilmalcolm in Renfrewshire *a*, *b*, G = 2·076...2·088, by Thomson, *c* by Connel, from Rübendörfel near Aussig, *d* by Hoffmann, *e*, *f* (mean of two) by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	48·76	49·20	50·14	48·18	48·36	47·68
Alumina	17·44	17·91	17·48	19·27	18·62	17·91
Lime	10·47	9·64	8·47	9·65	9·73	9·51
Soda	—	—	—	1·54	0·25	not det.
Potash	1·55	1·92	2·58	0·21	2·56	
Water	21·72	20·41	20·83	21·10	20·47	

Analyses of chabasie *g* from Parsborough in Nova Scotia, *h* from Fassathal, both by Hoffmann, *i* from Gustavsberg in Jemtland by Berzelius, *k* from Port Rush, G = 2·472, by Thomson, from the basalt of Annerode near Giessen, *l* by Genth, *m* by Engelhardt:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	51·46	48·63	50·65	48·99	47·00	45·97
Alumina	17·65	19·52	17·90	19·77	19·71	18·52
Red ox. iron	0·85	—	—	0·40	0·15	0·13
Lime	8·91	10·22	9·37	4·07	10·63	10·47
Soda	1·09	0·56	—	6·07	0·65	Mg 0·25
Potash	0·17	0·28	1·70	—	0·33	1·12
Water	19·66	20·70	19·90	20·70	22·29	23·54

Analyses of chabasie *n* from the Faröe islands, by Arfvedson, of the variety called phacolite from Leipa in Bohemia, *o* by Anderson, *p*, *q* by Rammelsberg:—

	n	*o*	*p*	*q*
Silica	48·38	45·63	46·20	46·46
Alumina	19·28	19·48	22·30	21·45
Red oxide of iron	—	0·43	—	—
Lime	8·70	13·30	10·34	10·45
Magnesia	—	0·14	0·34	—
Soda	—	1·68	1·77	0·95
Potash	2·50	1·31		1·29
Water	21·14	17·98	19·05	19·40

In a variety of chabasie from Nova Scotia, Rammelsberg found silica 55·99, of which 8·04 was insoluble in a solution of carbonate of soda, and must, consequently, be considered a mere mechanical mixture. The remaining constituents were—alumina with a little red oxide of iron 17·60, lime 7·21, soda 0·65, potash 0·90, water (loss) 17·65. A variety analyzed by Arfvedson was found to contain soda 12·19, and no lime.

In attached crystals and massive, in cavities and veins in amygdaloid, basalt, dolerite, phonolite; sometimes in beds and veins of metallic ores in plutonic rocks.

Is found at Rübendörfel near Aussig, Markersdorf and other places in Bohemia, the Westerwald, the Vogelsgebirge, the Breisgau, at Oberstein in Zweibrücken in agate balls, in Fassathal in the Tyrol, at Rheinbreitenbach, the Faröe islands, at Husavic in Iceland in cavities in fossil shells, Greenland, Gustafsberg in Sweden, the Giant's Causeway in Ireland, Kilmalcolm in Renfrewshire, Glen Farg in Perthshire, the islands of Skye, Mull, &c., Wisegrad in Hungary, Chester in Massachusetts, Werchneyudinsk on the Schilka in Siberia.

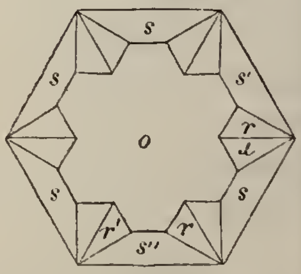
286. LEVYNE.—Makrotyper Kuphon-Spath; Mohs. Chabacit (in part); Hausmann. Levyn; Haidinger.

Rhombohedral. 100,111 = 43° 59′.

o 111, *r* 100, *s* $\bar{1}11$, *h* $\bar{5}44$.

ro	43°	59′
so	62	37
ho	70	57
rr′	73	56
ss′	100	31
hh′	109	53

FIG. 446.



Combination. *ors.* The faces *r*, *s* striated parallel to their intersections with each other; *o*, uneven and usually rounded.

Twin crystals. Twin-face *o*. Cleavage. *s*, indistinct. Fracture imperfect conchoidal. Semi-transparent. Lustre vitreous. White, sometimes greyish. Streak white. Brittle. H = 4·0. G = 2·1...2·2.

Chemical characters the same as those of chabasie.

Analyses of levyne from Faröe *a* by Berzelius, *b* by Arfvedson, *c* from Skye by Connel, *d* from Iceland by Damour :—

	a	*b*	*c*	*d*
Silica	48·00	48·38	46·30	44·48
Alumina	20·00	19·28	22·47	23·77
Lime	8·35	8·70	9·72	10·71
Magnesia	0·40	red ox. iron	0·96	—
Soda	2·86	—	1·55	1·38
Potash	0·41	2·50	1·26	1·61
Water	19·30	21·14	19·51	17·41

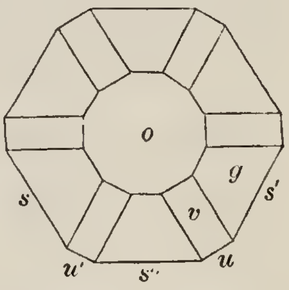
Is found in cavities in trap at Glenarm in Ireland, Hartfield-moss in Renfrewshire, Dalsnypen in the Faröe islands, Godhavn in Disco, Skaggastrand in Iceland, Skye.

287. GMELINITE.—Hydrolite; Beudant. Heteromorpher Kuphon-Spath; Mohs. Chabacit (in part); Hausmann. Gmelinit; Haidinger.

Rhombohedral.

so	90°	0′	*go*	40°	4′
uo	90	0	*vo*	36	4
uu′	60	0	*gs′*	49	56
ss″	60	0	*vu*	53	56
us′	30	0	*vg*	18	47

FIG. 447.



Combinations. *osg*, *osguv*. The faces *g* striated parallel to their intersections with *v*; *s* striated parallel to their intersections with *g*; *o*, rough. The crystals are supposed to be twins. Twin-face *o*. Fracture uneven. Translucent. Lustre vitreous. White, passing into flesh-red. Streak white. Brittle. H = 4·5. G = 2·04...2·12.

In the matrass yields water and falls to powder. Fuses before the blowpipe into an opaque glass. Is decomposed by hydrochloric acid, forming a perfect jelly of silica.

$\dot{\mathrm{R}}\ddot{\mathrm{Si}} + \dddot{\mathrm{Al}}\ddot{\mathrm{Si}}^3 + \dot{\mathrm{H}}^6$, where $\dot{\mathrm{R}}$ is soda, lime and potash.

Analyses of gmelinite *a* from Castel by Vauquelin, *b* from Glenarm by Connel, *c*, *d* from Glenarm by Rammelsberg, *e*, *f* from Aci-Reale (herschelite), G = 2·06, by Damour:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	50·00	48·56	46·40	46·56	47·39	47·46
Alumina.	20·00	18·05	21·08	20·19	20·90	20·18
Red ox. iron . . .	—	0·11	—	—	—	—
Lime	4·25	5·13	3·67	3·89	0·38	0·25
Soda	4·25	3·85	7·29	7·09	8·33	9·35
Potash	—	0·39	1·60	1·87	4·39	4·17
Water	20·00	21·66	20·41	20·41	17·84	17·65

Gmelinite is found coating the cavities of amygdaloidal rocks at Montecchio Maggiore and Castel in the Vicentine, Glenarm and the island Magee near Larne in Ireland. Herschelite is found at Aci di Castello near Aci-Reale in Sicily.

Gmelinite sometimes occurs imbedded in chabasie, the axis of the rhombohedron of chabasie being perpendicular to the face *o* of gmelinite, and the edges *gu* parallel to the faces *r*. According to Hausmann, levyne, gmelinite, herschelite are varieties of chabasie. Tamnau has shown that, allowing for errors of measurement, such a relation exists between the forms of these substances, that they may be considered as belonging to one and the same crystalline species. *vo* in gmelinite is very nearly equal to *to* in chabasie.

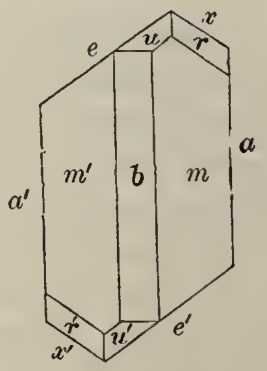
288. LAUMONITE.—Laumonite; Phillips, Hauy. Diatomer Kuphon-Spath; Mohs. Laumontit; Hausmann. Laumonit; Haidinger.

Oblique. 101,100 = 46° 37′; 111,010 = 66° 43′; 101,001 = 52° 41′.

a 100, *b* 010, *u* 011, *x* 102, *e* $\bar{1}02$, *r* 111.

ab	90°	0′	*um*	74°	11′
xb	90	0	*mb*	43	8
eb	90	0	*mm′*	86	16
ax	68	40	*rb*	66	43
xe	57	1	*rx*	31	38
ea′	54	19	*xm*	75	40
ub	59	43	*em′*	66	30
ue	39	19			

FIG. 448.



Combinations. *em*, *emab*, *exmb*, *exmbur*. The faces *a*, *m*, *b* striated parallel to their intersections with each other.

Cleavage. *b*, perfect; *a*, *m*, *e* imperfect. Fracture uneven. Translucent...translucent on the edges. Lustre vitreous, sometimes inclining to pearly. Yellowish and greyish white, rarely flesh-red. Streak white. Very brittle. H = 3·5. G = 2·33 ...2·41.

In the matrass yields water. Intumesces before the blowpipe and melts into a white glass which in a strong heat becomes transparent. Is decomposed by hydrochloric acid and nitric acid, forming a jelly of silica. Exposed to the air it effloresces and becomes opaque, in consequence of the escape of the water contained in it, and at last falls into a white powder.

$\dot{\mathrm{Ca}}\ddot{\mathrm{S}} + \dddot{\mathrm{Al}}\ddot{\mathrm{Si}}^3 + \dot{\mathrm{H}}^4$, silica 51·8, alumina 21·5, lime 11·3, water 15·4.

Analyses of laumonite *a* from Huelgoet by L. Gmelin, *b* from Philipsburg in Maine, *c* from Courmayeur, both by Dufrénoy, *d* from the parish of Snizort in the island of Skye by Connel, *e* in opaque crystals by v. Babo, *f* by Delffs:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	48·3	51·98	50·38	52·04	52·3	51·17
Alumina	22·7	21·12	21·43	21·14	22·3	21·23
Lime	12·1	11·71	11·14	10·62	12·0	12·43
Water	16·0	15·05	16·15	14·92	14·2	15·17

Analyses of laumonite *g* from Huelgoet, G = 2·29, by Malaguti and Durocher, *h*, pulverulent, from cavities in the porphyry of the Cordillera of Peuco in Chile by Domeyko, *i* from Schemnitz (leonhardite), G = 2·25, by Delffs, *k* (leonhardite) by v. Babo:—

	g	*h*	*i*	*k*
Silica	52·47	50·1	54·92	55·00
Alumina	22·56	19·9	22·49	24·36
Lime	9·41	14·1	9·05	10·50
Water	15·56	16·0	13·54	12·30

In attached crystals and massive, as a constituent of some greenstones, in veins in slate rocks, porphyry and trap, in the cavities of amygdaloid.

Is found in veins of lead ore at Huel Goet in Bretagne, at Eule in Bohemia, the Rothe-Kopf in the Zillerthal in the Tyrol, St. Gotthardt, the valley of Chamouni, Cormayeur, at Borsa and Schemnitz (leonhardite) in Hungary, Fahlun in Sweden, Bogoslowsk in the Ural, North America, in trap in the Faröe islands, Iceland, Loch Enort in Skye, and Portrush in Ireland, in the Kilpatrick hills in Dumbartonshire and Paisley in Scotland.

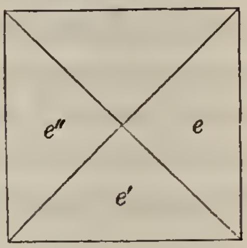
289. FAUJASITE. — Faujassite; Dufrénoy. Faujasit; Hausmann, Haidinger.

Pyramidal. 101,001 = 52° 45′.

e 101.

ee''	105°	30′
ee'	68	30

FIG. 449.



Twin. Twin-face *e*. Fracture uneven. Transparent...translucent on the edges. Lustre vitreous, inclining to adamantine. Colourless, white, brown. Brittle. H = 5·0. G = 1·923.

In the matrass yields water. Before the blowpipe intumesces and melts into a white enamel. Is decomposed by hydrochloric acid.

Analyses by Damour, the mineral in the latter being more free from impurity than in the former:—

Silica	49·36	46·12
Alumina	16·77	16·81
Lime	5·00	4·79
Soda	4·34	5·09
Water	22·49	27·02

Is found in the cavities of an amygdaloidal rock at Sassbach on the Kaiserstuhl in the Breisgau.

According to Blum, the crystals of faujasite belong to the cubic system. Simple form *o* 111.

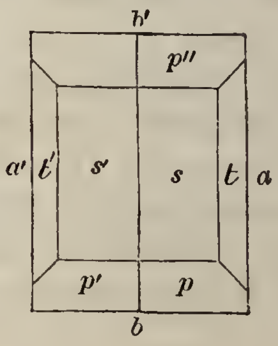
290. HARMOTOME.—Harmotome; Phillips, Hauy. Paratomer Kuphon-Spath; Mohs. Harmotom; Hausmann, Haidinger.

Prismatic. 011,010 = 54° 23′; 101,001 = 34° 47′; 110,100 = 45° 53′.

a 100, *b* 010, *s* 101, *t* 201, *p* 111, *m* 110 twin-face, *v* 414. *v* truncates the edge *sp*.

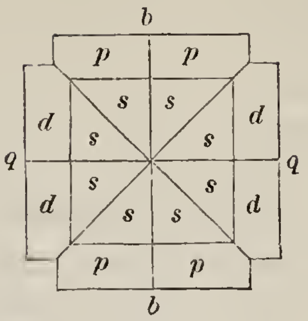
ab	90°	0′
sa	55	13
ss'	69	34
ta	35	45
tt'	108	30
pa	60	33
pp'	58	54
pb	59	32

FIG. 450.



pp''	60° 56′
$p'p''$	89 52
ps	30 28
ma	45 53
mb	44 7
vb	81 38
vs	8 22

FIG. 451.



Combinations. *pba*, *spba*, *sptba*. The faces *s*, *p* striated parallel to their intersections with each other; *b*, faintly striated parallel to its intersections with *p*. Twins. Twin-face *m*. Cleavage. *a*, distinct; *b*, less distinct. Fracture uneven...imperfect conchoidal. Transparent...translucent. Lustre vitreous. Colourless, white; seldom grey, yellow, brown, red. Streak white. Brittle. H = 4·5. G = 2·39...2·50.

In the matrass yields water. Melts before the blowpipe, not very readily, without intumescence, into a transparent white glass. In powder is completely decomposed by hydrochloric acid, leaving silica in powder.

$\dot{\mathrm{Ba}}\ddot{\mathrm{Si}}^2 + \dddot{\mathrm{Al}}\ddot{\mathrm{Si}}^3 + \dot{\mathrm{H}}^5$, silica 47·13, alumina 15·70, barytes 23·39, water 13·78.

Analyses of harmotome *a*, *b* from Andreasberg, *c* from Oberstein, all by Köhler, *d*, *e* from Andreasberg by Rammelsberg, *f* from Schiffenberg near Giessen by Wernekink:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	46·63	45·50	46·65	48·74	48·68	44·79
Alumina . .	16·82	16·42	16·54	17·65	16·83	19·28
Barytes . . .	20·32	20·09	19·12	19·22	20·09	17·59
Lime	0·26	1·80	1·10	—	—	1·08
Potash . . .	1·03	1·12	1·10	—	$\dot{\mathrm{Fe}}$, Mn	0·85
Water . . .	15·03	15·00	15·25	14·66	14·68	15·32

Analyses of harmotome from Strontian *g* by Köhler, *h* by Connel, *i*, G = 2·447, *k* in small transparent crystals, G = 2·498, both by Damour:—

	g	*h*	*i*	*k*
Silica	46·10	47·04	47·74	47·60
Alumina	16·41	15·24	15·68	16·39
Red oxide of iron . .	—	0·24	0·51	0·65
Barytes	20·81	20·85	21·06	20·86

	g	*h*	*i*	*k*
Lime	0·63	0·10	—	—
Potash	0·90	0·88	0·78	0·81
Soda	—	0·84	0·80	0·74
Water	15·11	14·92	13·19	14·16

In attached crystals in metallic veins in slate and transition rocks, in cavities of amygdaloidal rocks and basalt.

Is found at Strontian in Scotland in veins, at Andreasberg in the Harz and Kongsberg in Norway, Rudelstadt in Silesia, in cavities of amygdaloidal rocks in the Schiffenberg near Giessen, at Oberstein on the Nahe, the Blaue Kuppe near Eschwege.

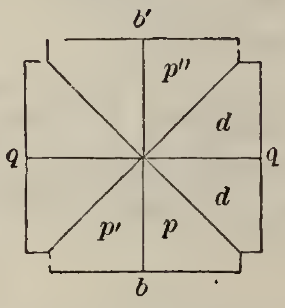
291. PHILLIPSITE.—Staurotyper Kuphon-Spath; Mohs. Phillipsit; Hausmann, Haidinger.

Prismatic. 011,010=54° 27′; 101,001=34° 59′; 110,100=45° 36′.

a 100, *b* 010, *s* 101, *m* 110 twin-face, *p* 111. *s* truncates the edge *pp″*.

ab	90°	0′
sa	55	1
ss′	69	58
mb	44	24
pp′	59	18
pp″	60	42
p′p″	90	0

FIG. 452.



Combinations. *pab*, *psab*. The faces *p*, *b* striated parallel to their intersections with each other; sometimes curved. Twins. Twin-face *m*. Cleavage. *a*, distinct; *b*, less distinct. Fracture conchoidal...uneven. Translucent...translucent on the edges. Lustre vitreous. Colourless, white, inclining to grey, blue, yellow, red. Streak white. Brittle. H = 4·5. G = 2·14...2·213.

In the matrass yields water. Melts before the blowpipe into a clear glass. Is readily decomposed by hydrochloric acid, forming a jelly of silica.

$\dot{R}\ddot{Si} + \dddot{Al}\ddot{Si}^3 + \dot{H}^5$, where $\dot{R}$ denotes lime, potash and soda.

Analyses of phillipsite *a*, *b* from the Stempel near Marburg by L. Gmelin, *c* from the Stempel, *d* from Habichtswalde near

Cassel, both by Köhler, *e*, *f* from Annerode near Giessen by Wernekink:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	48·51	48·02	50·44	48·22	48·36	53·07
Alumina	21·76	22·61	21·78	23·33	20·20	21·31
Red ox. iron . . .	0·99	0·18	—	—	0·41	—
Ox. ir. man. . . .	—	—	—	—	—	0·56
Lime	6·26	6·56	6·50	7·22	5·91	6·67
Potash	6·33	7·50	3·95	3·89	6·41	—
Barytes	—	—	—	—	0·46	0·39
Water	17·23	16·75	16·82	17·56	17·09	17·09

Analyses of phillipsite *g* from the Giant's Causeway, G = 2·17, by Connel, *h* from the Stempel near Marburg by Genth, *i*, *k* from Dyrefjord on the west coast of Iceland, G = 2·201, by Damour:—

	g	*h*	*i*	*k*
Silica	47·35	48·17	48·41	47·96
Alumina	21·80	21·11	22·04	22·37
Red oxide of iron . .	—	0·24	—	—
Lime	4·85	6·97	8·49	7·15
Potash	5·55	6·61	6·19	6·85
Soda	3·70	0·63	—	—
Water	16·96	16·62	15·60	15·67

In attached crystals and globular aggregations, in cavities in amygdaloid, basalt, phonolite.

Is found on the Habichtswalde near Cassel, the Stempel near Marburg, Annerode near Giessen, the Kaiserstuhl in the Breisgau, Leipa, Kamnitz and the Feuermauer near Töplitz in Bohemia, Sirknitz near Löwenberg in Silesia, Oberstein, Mendeburg near Bonn, Vesuvius, the Giant's Causeway in Ireland.

It has been supposed that gismondine, or zeagonite, from Capo-di-Bove near Rome, is a variety of phillipsite. Three twin crystals of this substance, having the form of phillipsite, sometimes cross nearly at right angles to each other. Occasionally a number of such crystals are united so that the faces *p* lie nearly in one plane, and the faces *a*, *b* disappear. The group then assumes the form of a double four-sided pyramid, on the faces of which may be observed the lines of junction of the different crystals of which it is composed. (Brooke, Phil. Mag. 1837, 10. 170.)

Analyses of a mineral called phillipsite, *a*, *b* transparent, *c* opaque, from Vesuvius, G = 2·213, all by Marignac, *d*, *e* of zeagonite by v. Kobell :—

	a	*b*	*c*	*d*	*e*
Silica	43·64	42·87	43·95	42·60	42·84
Alumina	24·39	25·00	24·34	25·50	26·04
Lime	6·92	7·97	5·31	7·50	7·70
Potash	10·35	9·20	11·09	6·80	5·76
Water	15·05	15·44	15·31	17·66	17·66

In analysis *c* the loss 11·09 is assumed to be potash.

A light blue zircon from Vesuvius has sometimes been called zeagonite.

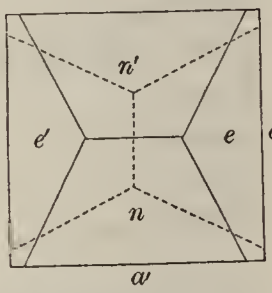
292. EDINGTONITE. — Pyramidaler Brythyn-Spath; Mohs. Edingtonit; Hausmann, Haidinger.

Pyramidal. 101,001 = 43° 39′·5.

a 100, *e* 101, *n* 012. The forms to which *e*, *n* belong are hemihedral with inclined faces.

aa′	90°	0′
ee′	87	19
na′	64	34
nn′	50	52

FIG. 453.



Combination. *ae′n′*. Cleavage. *a*, very distinct. Fracture imperfect conchoidal...uneven. Semi-transparent...translucent. Lustre vitreous. Greyish-white. Streak white. Brittle. H = 4·0...4·5. G = 2·71.

In the matrass yields water, and becomes white and opaque. Before the blowpipe in a strong heat melts into a colourless glass. In hydrochloric acid forms a jelly without being completely decomposed.

Analysis of a small quantity by Turner :—

Silica	35·09
Alumina	27·69
Lime	12·68
Water	13·32
Loss	11·22

The loss is probably potash or soda.

Was found in small crystals resting upon the mineral substance called cluthalite by Thomson in the amygdaloid of the Kilpatrick hills near Dumbarton in Scotland.

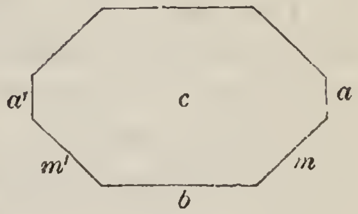
293. COMPTONITE.—Thomsonite, Comptonite; Phillips, Beudant. Orthotomer Kuphon-Spath, Peritomer Kuphon-Spath; Mohs. Comptonit; Hausmann. Thomsonit; Haidinger.

Prismatic.

a 100, *b* 010, *c* 001, *m* 110.

ac	90°	0′
bc	90	0
ma	45	20
mb	44	40
ba	90	0
mm′	89	20

FIG. 454.



The faces *m* usually striated parallel to their intersections with *a* and *b*; *c*, very uneven. Cleavage. *a*, perfect; *b*, less perfect; *c*, traces. Fracture imperfect conchoidal. Transparent...translucent. White, inclining to grey, yellow, red. Streak white. Brittle. H = 5·0...5·5. G = 2·31...2·38.

In the matrass yields water. Intumesces before the blowpipe, becomes opaque, and melts with difficulty into a white enamel. Is decomposed by hydrochloric acid, forming a jelly of silica.

$3\dddot{Al}\ddot{Si} + 3\dot{Ca}\ddot{Si} + 7\dot{H}$, silica 38·2, alumina 31·6, lime 17·2, water 13. A considerable portion of the lime is sometimes replaced by soda.

Analyses of comptonite from the Kilpatrick hills *a* by Berzelius, *b*, *c* by Thomson, *d*, *e* from Lochwinnock in Renfrewshire by Thomson, *f* from Dalsnypen by Retzius, *g* from Seeberg near Kaden by Zippe, *h* from Seeberg by Rammelsberg, *i* from Elbogen by Melly:—

	a	*b*	*c*	*d*	*e*
Silica	38·30	34·63	37·08	36·80	37·56
Alumina	30·70	32·35	33·02	31·36	31·96
Lime	13·54	18·65	10·75	15·40	15·10
Soda	4·53	1·25	3·70	$\dot{Mg}$ 0·20	1·08
Red oxide of iron	—	—	—	0·60	0·72
Water	13·10	14·00	13·00	13·00	13·20

	f	*g*	*h*	*i*
Silica	39·20	38·25	38·74	37·00
Alumina	30·05	32·00	30·84	31·07
Lime	10·58	11·96	13·43	12·60

	f	*g*	*h*	*i*
Soda	8·11	6·53	3·85	6·25
Red oxide of iron	0·50	—	$\dot{K}$ 0·54	—
Water	13·40	11·50	13·10	12·24

In attached crystals, globular, and reniform, in amygdaloidal cavities of basalt, phonolite, and old lavas, with calcite, chabasie, stilbite, phillipsite and apophyllite.

Is found on Vesuvius, Seeberg near Kaden, Schreckenstein on the Elbe, the Strizizowitz mountain, the Kelchberg near Triebsch, the Pflasterkaute near Eisenach in Hessia, Hauenstein, near Böhmisch Kamnitz and Böhmish Leipa, Daubitz and other places in Bohemia, Greenland, Iceland, the Faröe and Cyclopean islands, the Tyrol, in trap with analcime and prehnite on the Kilpatrick hills near Dumbarton in Scotland.

The surface of *c* is frequently uneven, forming apparently two planes. The angle between these surfaces differs considerably in different crystals.

294. ALGERITE.—Algerite ; Hunt.

Oblique.

a 100, *b* 010, *m* 110.

mm′ 94°.

Cleavage. *m*, imperfect. Translucent...opaque. Lustre vitreous, inclining to pearly on the cleavages. Yellowish-white, straw-yellow ; becomes a deep brownish-yellow after exposure. Streak light brown. H = 3·0...3·5. G = 2·697...2·948.

In the matrass yields water. Intumesces before the blowpipe and melts at a high temperature, with phosphorescence, into a porous white enamel. Slightly acted upon by hydrochloric acid.

Analyses by T. S. Hunt and Crossley :—

Silica	52·16	52·00
Alumina	26·08	25·42
Red oxide of iron	1·94	1·54
Magnesia	1·20	5·39
Potash	10·69	10·38
Water	7·92	5·27

Is found in crystals imbedded in white crystalline limestone at Franklin, Sussex county, New Jersey.

TITANATES.

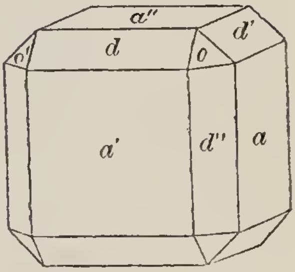
295. PEROWSKITE.—Perowskite; Dufrénoy. Perowskit; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *g* 320, *i* 430, *l* 540, *m* 311, *p* 122, *z* 944.

aa′	90°	0′	*ld″*	6°	20′
oo′	70	32	*ma*	25	14
oa	54	44	*ma′*	72	27
dd′	60	0	*mo*	29	30
da′	45	0	*pa*	70	32
ga	33	41	*pa′*	48	11
gd″	11	19	*po*	15	48
ia	36	52	*za*	32	9
id″	8	8	*zo*	22	35
la	38	40			

FIG. 455.



Cleavage. *a*, tolerably perfect. Opaque. Lustre adamantine, inclining to metallic, bright. Greyish-black...iron-black, sometimes dark reddish-brown. Streak greyish-white. H = 5·8. G = 3·99...4·017.

Infusible before the blowpipe. Soluble in borax. With a very small quantity of the mineral the bead is light yellowish-green while hot, and colourless when cold; with a larger quantity of the mineral the bead is brown when cold. In powder is but slightly acted upon by hydrochloric acid.

$\dot{Ca}\ddot{Ti}$, titanic acid 58·90, lime 41·10.

Analyses by Jacobson and Brooks:—

Titanic acid	58·96	59·00
Lime	39·20	36·76
Magnesia	trace	0·11
Protoxide of iron . . .	2·06	4·79

Is found in crystals in micaceous limestone at Vogsburg on the Kaiserstuhl, and in chlorite slate at Achmatowsk near Slatoust in the Ural.

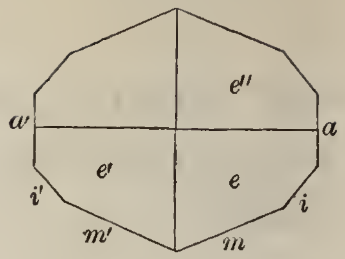
296. MENGITE.—Mengit; Mohs, Hausmann, Haidinger.

Prismatic. 011,010=48° 57′; 101,001=19° 14′; 110,100=68° 10′.

a 100, *m* 110, *i* 310, *e* 111.

ma	68°	10′
ia	39	46
mm′	43	40
ii′	100	28
ee′	28	33
ee″	78	50
em	46	50
e′e″	86	20

FIG. 456.



Combination. *aime.* Surface smooth and bright. No cleavage observable. Fracture uneven...conchoidal. Opaque. Lustre metallic, imperfect. Iron-black. Streak brown. H = 5·0...5·5. G = 5·43.

Infusible before the blowpipe; becomes magnetic. With borax and salt of phosphorus melts into a clear glass. In the outer flame imparts a greenish-yellow colour to salt of phosphorus; in the inner flame, with the addition of tin, a yellowish-red colour. Imparts a green colour to soda on platinum foil. Is completely soluble in hot concentrated sulphuric acid.

It is supposed to contain oxides of iron and manganese, titanic acid and zirconia.

In small crystals imbedded in albite in the Ilmen mountains near Miask in Siberia.

This mineral was given by Mengé to Mr. Brooke as the ilmenite of Fischer, and was accordingly described by him under that name. But as the titanic iron-oxide from Miask now passes under the same name, which it may be convenient, for the present at least, that it should retain, we have adopted the suggestion of Professor G. Rose, of designating this species as mengite.

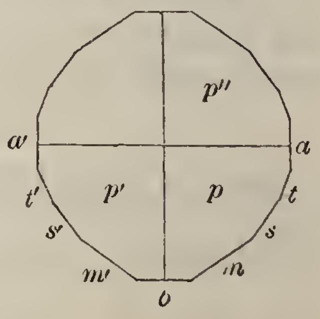
297. POLYMIGNYTE.—Polymygnite; Beudant. Prismatisches Melan-Erz; Mohs. Polymignyt; Hausmann. Polymignit; Haidinger.

Prismatic. 011,010=55° 24′·5; 101,001=31° 24′; 110,100=54° 53′.

a 100, *b* 010, *c* 001, *m* 110, *s* 210, *t* 410, *p* 111.

bc	90°	0′	*tt′*	140°	51′
ca	90	0	*pa*	68	14
ab	90	0	*pb*	58	11
ma	54	53	*pc*	40	8
mb	35	7	*pm*	49	52
mm′	70	14	*pp′*	43	32
sa	35	25	*pp″*	63	38
sb	54	35	*p′p″*	80	16
ss′	109	10			

FIG. 457.



Combinations. *pbam*, *pbamst*. The faces *a*, *b*, *m*, *s*, *t* striated parallel to their intersections with each other; the other faces smooth. Cleavage. *b*, imperfect; *a*, traces. Fracture conchoidal. Opaque. Lustre metallic, imperfect. Iron-black. Streak dark brown. Brittle. H = 6·5. G = 4·75...4·81.

Unchangeable before the blowpipe. With borax yields a glass coloured by iron. Imparts a reddish colour to salt of phosphorus in the inner flame. With soda does not fuse, but yields the reaction of manganese. In powder is decomposed by concentrated sulphuric acid.

Analysis by Berzelius:—

Titanic acid	46·30
Zirconia	14·14
Red oxide of iron	12·20
Lime	4·20
Oxide of manganese	2·70
Oxide of cerium	5·00
Yttria	11·50

With traces of potash, magnesia, silica and oxide of tin.

Is found in small crystals, elongated in the direction of the edge *ab*, in the zircon-syenite of Friedrichswärn in Norway. It is said to occur also in basalt near Porsgrund in Norway.

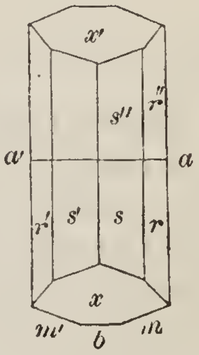
298. POLYKRASE.—Polykrase; Dufrénoy. Polykras; Hausmann, Haidinger.

Prismatic. 011,010 = 46° 46′; 101,001 = 18° 53′; 110,100 = 70° 0′.

a 100, *b* 010, *x* 021, *m* 110, *s* 111, *r* 311.

ab	90°	0′	*sb*	48°	20′
ma	70	0	*s′s″*	90	2
mb	20	0	*sm*	44	59
mm′	40	0	*ra*	53	12
xb	28	0	*rb*	56	46
xx′	124	0	*r′r″*	108	37
sa	76	0			

FIG. 458.



No cleavage observable. Fracture conchoidal. In thin fragments translucent. Lustre metallic, imperfect. Black, by transmitted light yellowish-brown. Streak greyish-brown. H = 6·0. G = 5·105.

In the matrass decrepitates. Ignited quickly glows like gadolinite, and assumes a light brown colour, but without any change of specific gravity. Infusible before the blowpipe. Soluble in borax, imparting to the bead a yellow colour in the outer flame, and a yellowish-brown colour in the inner flame. Imperfectly decomposed by hydrochloric acid. Is completely decomposed by hot sulphuric acid.

According to Scheerer contains titanic acid, tantalic acid, zirconia, yttria, red oxide of iron, oxide of uranium and cerium, a small quantity of alumina, magnesia and perhaps some alkali.

Is found in crystals in granite veins at Hitteröe in Norway.

TANTALATES, NIOBATES, SCHEELATES, MOLYBDATES.

299. PYROCHLORE. — Pyrochlore ; Phillips, Beudant. Oktaedrisches Titan-Erz ; Mohs. Pyrochlor ; Hausmann, Haidinger.

Cubic.

a 100 cleavage, *o* 111, *d* 011, *n* 211, *m* 311.

aa′	90° 0′	*do*	35° 16′	*nd*	30° 0′
oo′	70 32	*da′*	45 0	*mo*	29 30
oa	54 44	*no*	19 28	*md*	31 29

FIG. 459.

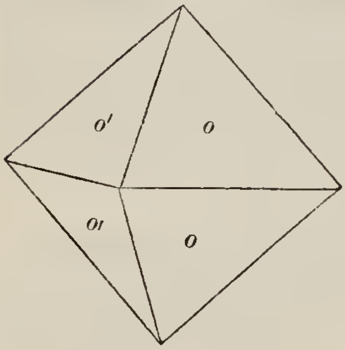


FIG. 460.

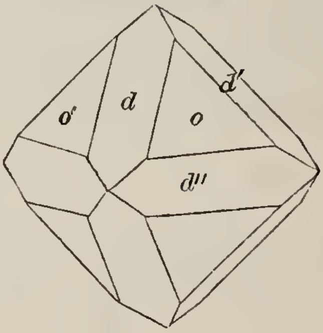
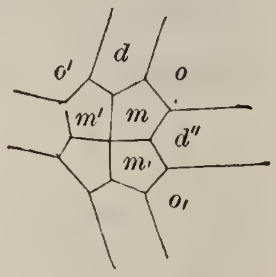


FIG. 461.



Form and combinations. *o, od, on, odn, odm.* Cleavage. *a, o* scarcely observable. Fracture conchoidal. Translucent on the edges...opaque. Lustre resinous, inclining to vitreous. Dark reddish-brown, blackish-brown on a freshly fractured surface. Streak light brown. Rather brittle. H = 5·0...5·5. G = 4·19...4·33.

Before the blowpipe turns yellow and melts with great difficulty into a blackish-brown slag. With borax yields a glass which is reddish-yellow in the outer flame, and dark red in the inner flame. The varieties from Brevig and Friedrichswärn yield the reaction of uranium. In powder is completely decomposed by concentrated sulphuric acid.

Analyses of pyrochlore *a* from Miask by Wöhler, *b* from Miask by Hermann, *c*, *d* from Brevig, G = 3·8, by Wöhler :—

	a	*b*	*c*	*d*
Tantalic acid	67·38	62·25	67·02	67·77
Titanic acid	—	2·23	—	—
Zirconia	—	5·57	—	—
Oxide of cerium . . .	13·15	3·32	5·16	not det.
Thorina		—		
Oxide of lanthanium . .	—	2·00	—	—
Lime	10·98	13·54	9·88	10·13
Protoxide of iron . . .	1·29	(F̈e 5·68)	1·33	—
Protox. mangan. . . .	0·15	0·70	1·69	—
Yttria	0·81		—	—
Potash, soda, lithia . .	—	3·72	—	—
Sodium	3·93	ox. uran.	4·60	5·71
Fluorine	3·23	not det.	—	—
Water	1·16	0·50	7·06	7·42

In small crystals and grains in syenite near Friedrichswärn and in the island of Lövö near Brevig in Norway, in granite in the Ilmen mountains near Miask in the Ural.

In pyrochlore from Miask G. Rose found G = 4·320; in pyrochlore from Friedrichswärn G = 4·206...4·216. For pyrochlore from Friedrichswärn, from a very small quantity, Wöhler found G = 4·802.

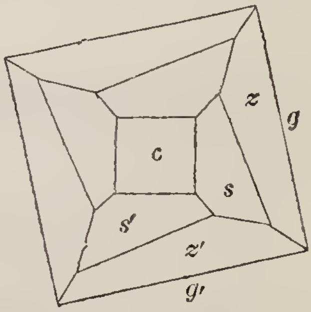
300. **FERGUSONITE.**—Fergusonite; Beudant. Pyramidales Melan-Erz; Mohs. Fergusonit; Hausmann, Haidinger.

Pyramidal. 101,001 = 55° 40′.

c 001, *s* 111, *g* 320, *z* 321. The forms *g*, *z* are hemihedral with parallel faces.

gc	90°	0′
gg′	90	0
sc	64	14
ss′	79	6
zc	79	17
zz′	88	1
gcs	11	19

FIG. 462.



Combinations. *cg′*, *csg′*, *csz′g′*. Surfaces rather uneven. Cleavage. *s*, traces. Fracture conchoidal. Opaque; in thin splinters translucent. Lustre imperfect metallic, inclining to resinous; on surface of fracture vitreous, bright. Blackish-brown. Streak pale brown. Brittle. H = 5·5…6·0. G = 5·8…5·9.

Infusible before the blowpipe. With borax and salt of phosphorus dissolves with difficulty into a glass which is yellow while hot.

$\dot{R}^6\overset{\cdots}{Ta}$, where $\dot{R}$ is yttria, protoxide of cerium, zirconia.

Analysis by Hartwall:—

Tantalic acid	47·75
Yttria	41·91
Protoxide of cerium	4·68
Zirconia	3·02
Oxide of tin	1·00
Oxide of uranium	0·95
Protoxide of iron	0·34

Is found imbedded in quartz at Kikertaursak near Cape Farewell in Greenland.

301. EUXENITE.—Euxénite; Dufrénoy. Euxenit; Hausmann, Haidinger.

Fracture imperfect conchoidal. In thin splinters translucent. Lustre resinous, inclining to metallic. Brownish-black; by transmitted light reddish-brown. Streak reddish-brown. H = 6·5. G = 4·6.

Infusible before the blowpipe. In the outer flame imparts a brownish-yellow colour to borax. Not acted upon by acids.

Analyses *a* of a small quantity from Jölster, *b* of a very similar mineral, G = 4·73…4·76, from near Tvedestrand, both by Scheerer:—

	a		*b*
Tantalic acid with titanic acid	49·66		53·64
Titanic acid	7·94		
Yttria	25·09		28·97
Protoxide of uranium	6·34		7·58
Protoxide of cerium	2·18		2·91
Oxide of lanthanium	0·96	$\dot{Fe}$	2·60
Lime	2·47		—
Magnesia	0·29		—
Water	3·97		4·04

Is found at Jölster in Bergenhuus and Tvedestrand in Norway, and also at Arendal, containing niobic acid, but no tantalic acid.

302. YTTROTANTALITE. — Yttrotantalite ; Phillips. Yttrotantale ; Beudant. Yttertantal ; Mohs, Hausmann, Haidinger.

Cleavage in one direction, more or less distinct. Fracture conchoidal...uneven, granular. Opaque. Lustre imperfect metallic, inclining sometimes to resinous. Iron-black, brownish-black, yellowish-brown. Streak grey or white. H = 5·0... 5·5. G = 5·39...5·88.

Before the blowpipe becomes brown or yellow, but does not melt. Soluble in borax, forming a clear yellow glass. Is not acted upon by acids. Is completely decomposed by fusion with bisulphate of potash.

$\dot{R}^3\dddot{Ta}$, where $\dot{R}$ is $\dot{Y}$, $\dot{Ca}$, $\dot{Fe}$, $\dot{U}$, and part of the $\dddot{Ta}$ is replaced by $\dddot{W}$.

Analyses of yttrotantalite from Ytterby *a*, *b*, *c*, *d* by Berzelius, from the Ilmen mountains *e* by Hermann, *f* from Ytterby, after ignition, by which it lost 3·9...5·44 per cent., by v. Peretz :—

	a	*b*	*c*	*d*	*e*	*f*
Tantalic acid .	57·00	51·82	60·12	59·50	61·33	58·65
Scheelic acid .	8·25	2·59	1·04	1·25	($\dot{Mn}$ 1·00)	0·60
Yttria	20·25	38·52	29·78	29·90	19·74	21·25
Lime	6·25	3·26	0·50	3·29	2·08	7·55
Ox. uranium .	0·50	1·11	6·62	3·23	($\dot{U}$ 5·64	3·94)
Red ox. iron .	3·50	0·55	1·16	2·72	($\dot{Fe}$ 7·23	6·29)
Ox. copper . .	—	—	—	—	—	0·40
$\dot{Zr}$, $\ddot{Ti}$, $\dot{Ce}$, $\dot{La}$, $\dddot{W}$ . .	—	—	—	—	1·50	—
Magnesia . .	—	—	—	—	—	1·40
Water . . .	5·74	2·72	4·85	4·85	1·66	—

Is found in indistinctly formed crystals, and imbedded grains, in Sweden in a quarry at Ytterby near Maxholm in felspar with gadolinite and in the granite veins of Finbo and Kararfsberg near Fahlun ; in the Ilmen mountains near Miask in the Ural.

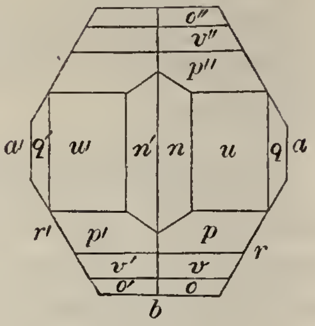
303. TANTALITE.—Tantalite ; Phillips, Dufrénoy. Prismatisches Tantal-Erz ; Mohs. Tantalit ; Hausmann, Haidinger.

Prismatic. 011,010=51° 24′ ; 101,001 = 33° 6′ ; 110,100=50° 46′.

a 100, *b* 010, *c* 001 cleavage, *q* 301, *u* 101, *n* 106, *r* 940, *p* 111, *v* 232, *o* 121.

bc	90°	0′	*rr′*	122°	54′
qa	27	2	*oo′*	38	12
ua	56	54	*oo″*	106	23
na	83	49	*o′o″*	119	45
ca	90	0	*vv′*	45	22
qq′	125	56	*vv″*	90	8
uu′	66	12	*v′v″*	107	27
nn′	12	22	*pp′*	54	0
ra	28	33	*pp″*	67	30
ba	90	0	*p′p″*	91	42

FIG. 463.



Cleavage. *a*, *b*, *c* all very imperfect. Fracture conchoidal… uneven. Opaque. Lustre imperfect metallic, passing into resinous. Iron-black. Streak brown. H = 6·0…6·5. G = 7·0…8·0.

Unchangeable before the blowpipe. In fine powder slowly soluble in borax, yielding a glass coloured by iron. With soda yields the reaction of manganese, and traces of tin in the inner flame. Is not acted upon by acids.

$\dot{\text{Fe}}\dddot{\text{Ta}}$, part of the $\dot{\text{Fe}}$ being replaced by $\dot{\text{Mn}}$.

Analyses of tantalite *a* from Tammela, G = 7·264, by Nordenskiöld, *b* from Kimito, streak coffee-brown, G = 7·03…7·3, by Berzelius, *c* from Tammela, streak dark reddish-brown, G = 7·197, by Jacobson, *d* the same by Brooks, *e* from Tammela, crystallized, G = 7·187, by Wornum, *f* from Chanteloupe, streak greyish-black, G = 7·651, by Damour:—

	a	*b*	*c*	*d*	*e*	*f*
Tantalic acid . . .	83·44	83·2	84·15	84·70	77·83	82·98
Oxide of tin . . .	—	0·6	0·32	0·50	6·81	1·21
Protox. iron . . .	13·75	7·2	14·68	14·29	8·47	14·62
Protox. mangan. . .	1·12	7·4	0·90	1·78	4·89	trace
Lime	—	—	0·07	—	0·50	—
Ox. copper . . .	—	—	1·81	0·04	0·24	$\ddot{\text{Si}}$ 0·42

In analysis *f* the nature of the metallic acids was not particularly inquired into.

A variety of tantalite from Broddbo, in which part of the tantalic acid is replaced by scheelic acid, differs in some of its properties from the tantalite from Tammela and Kimito. Fracture uneven. Opaque. Lustre vitreous. Iron-black. Streak black. H = 5·0…6·0. G = 6·2…6·4. Soluble in borax, forming a transparent yellowish glass, which becomes opaque in an interrupted blast. Sometimes it imparts a red colour to salt of phosphorus in the inner flame. With soda and a little borax yields tin in the inner flame.

Analyses of tantalite *g*, *h*, *k* from Broddbo by Berzelius :—

	g	*h*	*k*
Tantalic acid	66·66	68·22	66·35
Oxide of tin	8·02	8·26	8·40
Tungstic acid	5·78	6·19	6·12
Protoxide of iron	9·55	8·60	10·50
Protoxide of manganese .	9·17	6·43	5·90
Lime	—	1·19	1·50

In crystals, massive, in imbedded angular particles.

Is found imbedded in granite containing albite or oligoclase, seldom felspar, in Finland at Skogsböhle in the parish of Kimito, Katiala in the parish of Kuortane, Kiwiwuorenwehmais and Härkäsaari near Torro in the parish of Tammela, Kavitaskallio, on Björskär an island near Ekenäs, and at Kaidasuo near Penickoja in the parish of Somero. Mechanically mixed with a very variable proportion of oxide of tin at Finbo near Fahlun. The variety containing scheelic acid is found in crystalline grains imbedded in loose blocks of granite at Broddbo near Fahlun.

304. SAMARSKITE. — Uranotantal ; Hausmann, Haidinger.

Prismatic.

Isomorphous with niobite. Fracture conchoidal. Opaque. Lustre on surface of fracture bright, imperfect metallic. Velvet-black. Streak dark reddish-brown. H = 5·5. G = 5·617... 5·715. By ignition G is reduced from 5·715 to 5·3735.

Slightly heated in the matrass decrepitates, yields a little moisture, glows like gadolinite and assumes a blackish-brown colour. Before the blowpipe melts on the edges into a black glass. In powder is dissolved in borax, yielding in the inner flame a yellow glass, and in the outer flame a yellowish-green glass, which inclines to red on the addition of a large proportion of the mineral. Easily soluble in salt of phosphorus into a clear emerald-green glass. Soluble with difficulty in hydrochloric acid, forming a green solution.

Analyses of samarskite *a*, *b*, *c* from the Ilmen mountains, G = 5·617...5·68, by v. Peretz, *d*, *e* of yttroilmenite by Hermann :—

	a	*b*	*c*	*d*	*e*
Metallic acids	56·38	56·00	55·91	61·33	57·81
Yttria	9·15	11·04	8·36	19·74	18·30
Protox. iron	15·43	15·90	15·94	8·06	13·61
Protox. mangan.	0·92	1·02	1·88	1·00	0·31
Lime				2·08	0·50
Ox. uranium	14·16	16·70	16·77	$\dot{U}$ 5·64	1·87
Magnesia	0·80	0·75	0·75	$\ddot{Ti}$ 1·50	5·90
Protox. cer. ox. lanthan.	—	—	—	—	2·27
Loss ign.	—	—	—	1·66	—

The metallic acids in analyses *a*, *b*, *c* are a mixture of niobic and scheelic acids. The acid in analyses *d*, *e* is supposed by Hermann to be that of a new metal, ilmenium. According to H. Rose, it is a mixture of niobic and scheelic acids, which possesses all the properties of the substance called ilmenic acid.

Is found in imbedded flattened grains, with aeschynite, imbedded in felspar in the Ilmen mountains near Miask. According to H. and G. Rose, the mineral called yttroilmenite by Hermann is samarskite.

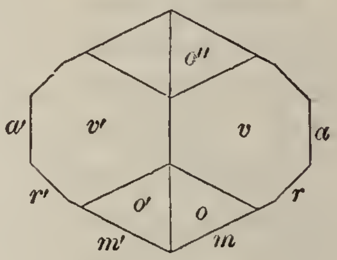
305. AESCHYNITE.—Aeschynite; Beudant. Dystomes Melan-Glanz, Mohs. Aeschynit; Hausmann, Haidinger.

Prismatic. 011,010=36° 31′; 101,001=33° 46′·4; 110,100=63° 39′·5.

a 100, *b* 010 cleavage, *c* 001, *v* 201, *m* 110, *r* 210, *o* 111.

ca	90°	0′	*oa*	68°	18′
mc	90	0	*oc*	56	26
va	36	47	*oo′*	43	24
vc	53	13	*oo″*	96	56
vv′	106	26	*o′o″*	112	52
mm′	52	41	*om*	33	34
rr′	89	26			

FIG. 464.



Combinations. *camv*, *camo*, *amrvo*. The faces *m*, *r*, *a* striated parallel to their intersections with each other; the other faces uneven. Cleavage. *b*, traces. Fracture imperfect conchoidal...uneven. Faintly translucent on the edges...opaque. Lustre imperfect metallic; the surfaces of fracture resinous, bright. Iron-black...brown; hyacinth-red by transmitted light. Streak yellowish-brown. Brittle. H = 5·5. G = 5·1...5·2.

In the matrass yields a little water and traces of hydrofluoric acid. Before the blowpipe intumesces and becomes yellow or brown, but is nearly infusible. With borax melts into a bead which is yellow while hot, and becomes colourless on cooling, and which, with the addition of tin, in the inner flame becomes red. With salt of phosphorus soluble with more difficulty into a clear bead, which, with tin, in the inner flame becomes purple. With bisulphate of potash dissolves into a dark yellow transparent mass, which becomes opaque on cooling. Is partially decomposed by concentrated sulphuric acid.

Analyses of aeschynite from Miask *a* by Hartwall, G = 5·08, *b*, G = 4·95, *c* both by Hermann:—

	a	*b*	*c*
Niobic acid	—	33·39	35·05
Titanic acid	56·0	11·94	10·56
Zirconia	20·0	17·52	17·58
Protoxide of iron	($\bar{\bar{\mathrm{Fe}}}$ 2·6)	17·65	4·32
Yttria	—	9·35	4·62
Oxide of lanthanium	—	4·76	11·13
Protoxide of cerium	(Ce^2O^3 15·0)	2·48	15·59
Oxide of tin	0·5	$\dot{\mathrm{Ca}}$ 2·40	—
Water with a trace of fluorine	—	1·56	1·66

The zirconia is perhaps the noria of Svanberg. Hermann supposes that in analysis *a* a mixture of niobic and titanic acids was mistaken for pure titanic acid.

Is found in crystals in a coarse-grained rock, consisting of felspar, albite and mica, near Miask in the Ural.

The first account of the crystals of this substance was, we believe, published by Mr. Brooke, in September, 1831. He described them as right rhombic prisms. Mr. Allan, in the fourth edition of Phillips, states them to have been described as oblique rhombic prisms, a mistake which has been copied by Mr. Alger in his edition of the same work.

306. NIOBITE.—Tantalite (in part); Phillips, Dufrénoy. Hemiprismatisches Tantal-Erz; Mohs. Columbit; Hausmann. Niobit; Haidinger.

Prismatic. 011,010=43° 22′; 101,001=41° 16′·6; 110,100=50° 20′.

a 100, *b* 010, *c* 001, *d* 013, *v* 023, *y* 016, *h* 201, *l* 310, *m* 110, *g* 120, *o* 111, *u* 313, *n* 613.

db	70°	34′	*vv′*	70°	25′	*ha*	29°	40′
yb	80	0	*dd′*	38	52	*ca*	90	0
cb	90	0	*yy′*	20	0	*hh′*	120	40

gb	22°	31′	*ob*	51°	29′	*nn′*	117°	44′
mb	39	40	*oc*	53	58	*nn″*	19	49
lb	68	6	*oo′*	62	7	*n′n″*	121	38
ab	90	0	*oo″*	77	2	*uc*	43	26
ll′	136	12	*o′o″*	107	56	*uu′*	79	11
mm′	79	20	*na*	31	8	*uu″*	29	43
gg′	45	2	*nc*	60	49	*u′u″*	86	52

FIG. 465.

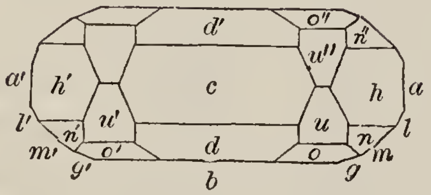
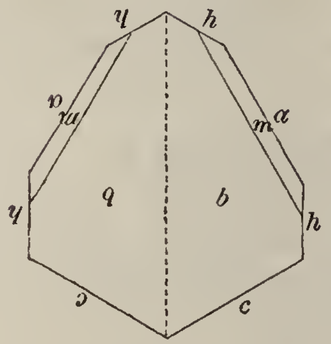


FIG. 466.



Combinations. *cbwe*, *cbame.h*, *cbwvdy*, *cbamghlen.o*. The faces *b* deeply striated parallel to their intersections with *a*. Twins. Twin-face *h*. *cɔ* = 59° 20′, *aɐ* = 120° 40′, *hɥ* = 61° 20′. Cleavage. *a*, *b* distinct, especially the latter; *c*, indistinct. Fracture imperfect conchoidal...uneven. Opaque. Lustre imperfect metallic, passing into adamantine on the faces and cleavages, and into resinous on the surface of fracture. Iron-black, brownish, greyish-black. Streak dark reddish-brown or brownish-black. H = 6·0. G = 5·32...6·39. Conducts electricity.

Infusible before the blowpipe. With borax forms a blackish-green glass which does not become opaque in an interrupted blast. Soluble in bisulphate of potash. Is not acted upon by acids.

Analyses of niobite *a*, *b* from Rabenstein, streak black, G = 6·39, *c* streak dark reddish-brown, G = 5·7, all by H. Rose, streak dark, G = 6·078, *d* by Awdejew, streak dark reddish-brown, G = 5·976, *e* by Jacobson, *f* from North America by Marignac:—

	a	*b*	*c*	*d*	*e*	*f*
Niob. pelop. acids .	81·07	81·34	79·68	80·64	79·73	77·30
Protox. iron . .	14·30	13·89	15·10	15·33	14·77	13·00
Protox. mangan. .	3·85	3·77	4·65	4·65	4·77	9·50
Oxide of tin . .	0·45	0·19	0·12	0·10	0·10	0·50
Ox. copper . . .	0·13	0·10	0·12		1·51	—
Lime	trace	trace	trace	0·21	—	—

Analyses of niobite from Middletown in Connecticut, streak dark reddish-brown, G = 5·32, *g* by Grewink, G = 5·469...5·495, *h* by Schlieper, *i* from North America, streak dark reddish-brown, G = 5·708, by H. Rose, *k* from the Ilmen mountains, G = 5·43...5·73, by Hermann, G = 5·461, *l* by Bromeis, *m* from Middletown in Connecticut, streak dark brown, G = 5·80, by Hermann :—

	g	*h*	*i*	*k*	*l*	*m*
Niob. pelop. acids	80·06	78·83	79·62	80·47	78·60	78·22
Protox. iron . .	12·59	16·66	16·37	8·50	12·76	14·06
Protox. mang. .	5·97	4·71	4·44	6·09	4·48	5·63
Yttria	—	—	—	2·00		—
Magnesia . . .	(Ṅi	0·22)	—	2·44	3·01	0·49
Ox. copper . .	0·44	0·07	0·06	—	Ẅ	0·26
Lime	—	0·45	—	—	0·75	—
Ox. tin . . .	—	0·29	0·47	—	—	0·40
Protox. uran. .	0·96	—	—	0·50	0·56	—

Analyses of niobite from Limoges, G = 5·60...5·727, by Damour :—

Pelopic and niobic acids . .	78·44	78·88	78·90	78·74
Protoxide of iron	14·96	14·04	14·50	14·50
Protoxide of mangan. . .	6·52	7·83	7·15	7·17

Is found in crystals and granular masses in granite, with beryl, on the Rabenstein near Zwiesel not far from Bodenmais, with yttroilmenite in a granite vein on the east side of lake Ilmen, with tourmaline, beryl, chrysoberyl at Haddam and Middletown in Connecticut, Chesterfield and Beverley in Massachusetts, and at Ackworth in New Hampshire.

307. WOLFRAM.—Tungstate of iron; Phillips. Scheélin ferruginé; Hauy. Prismatisches Scheel-Erz; Mohs. Wolfram; Hausmann, Haidinger.

Prismatic. 011,010=43° 19′; 101,001=40° 46′·7; 110,100=50° 52′·5.

a 100, *b* 010, *c* 001, *t* 012, *u* 101, *k* 203 twin-face, *r* 210, *m* 110, *l* 120, *o* 111, *s* 211, *z* 113. The forms *t*, *o*, *s*, *z* are usually hemihedral with parallel faces.

bc	90°	0′	*rr′*	116°	50′	*sb*	61°	58′
ca	90	0	*mm′*	78	15	*sc*	63	48
ab	90	0	*ll′*	44	16	*ss′*	99	43
tt′	56	3	*oc*	53	55	*ss″*	56	4
uu′	81	33	*oo′*	61	19	*s′s″*	127	36
kc	29	54	*oo″*	77	39	*zc*	24	35
ka	60	6	*o′o″*	107	50			

FIG. 467.

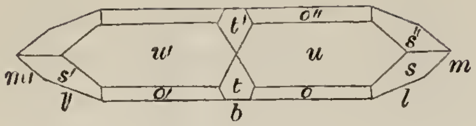


FIG. 468.

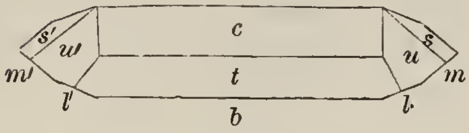


FIG. 469.

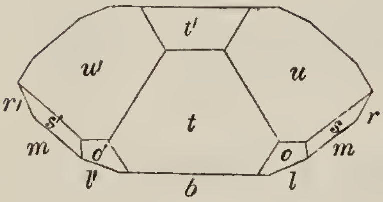


FIG. 470.

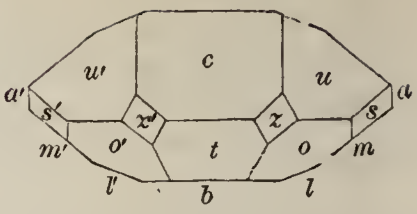
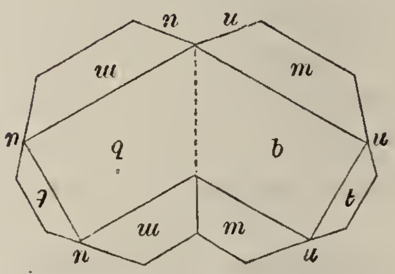


FIG. 471.



Combinations. *mus*, *bmut*, *abes.m*, *bulmos.t*, *mt'.l*, *bult'*, *mlut'*, *bulmto's'.r*, *bulmt'o's'*, *bculmt's'.c.o*, *abclmut'o's'z'*. The faces *b*, *l*, *m*, *r* striated parallel to their intersections with each other. Twins. 1. Twin-face *b*. 2. Twin-face *k*. The axes of the zones *mb*, *qu* make with each other an angle of 120° 12′, *un* = — 38° 39′. Cleavage. *a*, perfect; *b*, imperfect. Fracture uneven. Opaque. Lustre adamantine, inclining to metallic. Brownish-black. Streak reddish-brown...black. H = 5·5. G = 7·0...7·5. Sometimes slightly magnetic. Conducts electricity feebly.

Before the blowpipe on charcoal in a strong heat melts into a magnetic globule, the surface of which is covered with crystals. With borax yields the reaction of iron. With salt of phosphorus forms a bead which in the inner flame is dark red, and with the addition of tin becomes green. Imparts a green colour to soda. Soluble in bisulphate of potash. In powder is completely decomposed by hydrochloric acid, leaving a yellow residuum.

$\dot{\mathrm{R}}\dddot{\mathrm{W}}$, where $\dot{\mathrm{R}}$ is protoxide of iron and protoxide of manganese.

Analyses of wolfram *a* from Harzgerode, G = 7·143, by Rammelsberg, *b* from Limoges, mean of five, *c* from Zinnwald, mean of two, both by Ebelmen, *d*, *e*, *f* from Zinnwald by Kussin:—

	a	*b*	*c*	*d*	*e*	*f*
Scheelic acid . . .	75·56	76·20	75·99	75·89	75·92	75·90
Protox. iron . . .	20·17	19·19	9·62	9·43	9·38	9·40
Protox. mangan. .	3·54	4·48	13·96	13·80	14·04	13·86
Magnesia . . .	—	0·80	Ċa 0·48	—	—	—

Analyses of wolfram *g* from Ehrenfriedersdorf, G = 7·500, *h* from Nertschinsk, G = 7·496, *i* from Monte Video, G = 7·499, *k* from Chanteloupe, G = 7·480, *l* from Neudorf, G = 7·225, *m* from Godolphin's Ball, G = 7·21, all by Kerndt :—

	g	*h*	*i*	*k*	*l*	*m*
Scheelic acid . . .	75·85	75·64	76·02	75·83	75·90	75·92
Protox. iron . . .	19·26	19·55	19·20	19·33	19·25	19·35
Protox. mangan. . .	4·89	4·81	4·75	4·84	4·80	4·73

Analyses of wolfram *n* from Zinnwald, G = 7·2226, *o* from Lockfell in Cumberland, G = 7·231, *p* from Neubeschert Glück near Freiberg, G = 7·223, *q* from Huntingdon in Connecticut, G = 7·411, *r* from Trumbull in Connecticut, G = 7·218, *s* from Neudorf, G = 7·231, all by Kerndt :—

	n	*o*	*p*	*q*	*r*	*s*
Scheelic acid . . .	75·62	75·96	75·84	75·47	75·76	75·80
Protox. iron . . .	9·55	9·54	9·20	9·53	9·74	9·79
Protox. mangan. . .	14·85	14·50	14·56	14·26	14·50	14·41

Analyses of wolfram *t* from Schlackenwald, G = 7·482, *u* from Altenberg, or perhaps Zinnwald, G = 7·198, both by Kerndt, *v* from Zinnwald, G = 7·191, *w* from Monte Video, G = 7·544, *x* from Ehrenfriedersdorf, *y* from Chanteloupe, G = 7·437, all by Schaffgotsch :—

	t	*u*	*v*	*w*	*x*	*y*
Scheelic acid . . .	75·68	75·44	not estimated			
Protox. iron . . .	9·56	9·64	9·52	19·24	19·16	17·95
Protox. mangan. . .	14·30	14·90	14·98	4·97	4·74	6·05

Analyses *z* of wolfram from Zinnwald, *α* from the Glasebach mine near Strassberg in the Harz, *β* from the Pfaffenberg mine near Neudorf in the Harz, *γ*, *δ* from the Meiseberg mine near Neudorf in the Harz, all by Schneider, *ε* by Richardson :—

	z	*α*	*β*	*γ*	*δ*	*ε*
Scheelic acid . . .	76·01	76·04	76·21	76·30	76·27	73·60
Protox. iron . . .	9·81	19·61	18·54	20·12	20·38	11·20
Protox. mangan. . .	13·90	4·98	5·23	4·12	3·80	14·75

	z	α	β	γ	δ	ε
Lime	1·19	0·28	0·40	0·38	0·20	—
Magnesia	—	trace	0·36	0·16	0·07	—

In crystals; massive; pseudomorphous after scheelite.

Is found with oxide of tin in Bohemia at Schlackenwald and Zinnwald; in Saxony at Schneeberg, Geyer, Ehrenfriedersdorf, Freiberg and Altenberg; in France, in veins of quartz at Limoges and many other places; in the Harz, in veins containing galena, at Pfaffenberg, Meiseberg and Strassberg; in many mines near Redruth in Cornwall, in Cumberland, in granite veins in Rona, one of the Hebrides, Ceylon, Nertschinsk in Siberia, Connecticut, Monte Video in South America. The homohedral varieties were found at Nertschinsk and Schlackenwald.

The form of Wolfram approximates closely to that of niobite.

308. SCHEELITE.—Tungstate of lime; Phillips. Schéelin calcaire; Hauy. Pyramidaler Scheel-Baryt; Mohs. Scheelit; Hausmann, Haidinger.

Pyramidal. 101,001 = 56° 1′.

c 001, *e* 101, *u* 102, *d* 105, *n* 111, *v* 112, *s* 113, *z* 212, *x* 311, *m* 110 twin-face. The forms *z*, *x* are hemihedral with parallel faces.

mm′	90°	0′	*vu*	30°	47′	*xe′*	68°	6′
uc	36	34	*ve*	35	54	*zc*	58	55
ec	56	1	*z′e′*	22	39	*xc*	77	58
dd′	23	12	*ne′*	39	40	*xn*	28	26
dd″	33	3						
uu′	49	50						
uu″	73	8						
ee′	71	48						
ee″	112	2						
sc	34	58						
vc	46	22						
nc	64	31						
mc	90	0						
ss′	47	48						
ss″	69	56						
vv′	61	34						
vv″	92	44						
nn′	79	20						
nn″	129	2						

FIG. 472.

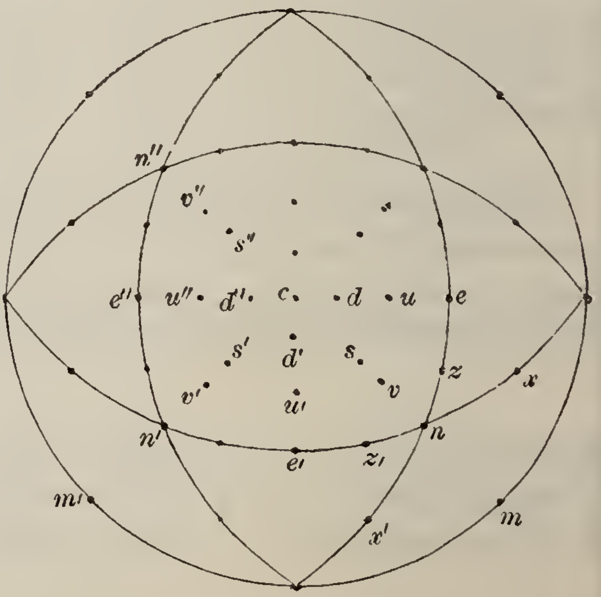


FIG. 473.

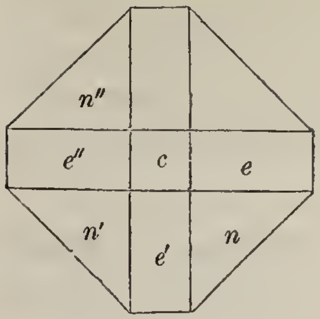


FIG. 474.

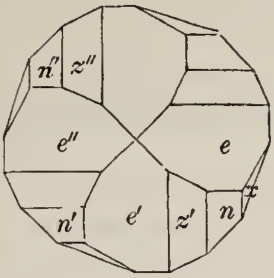
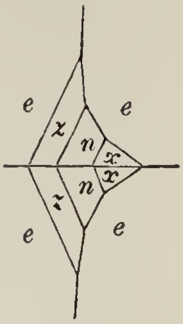


FIG. 475.



Forms and combinations. *e*, *n*, *cd*, *e..c.d.n.cn*, *enz'x'*, *usenx'*. The faces *c* usually rough. The faces *e* striated parallel to their intersections with *n* and *z*, sometimes concave. Twins. 1. Twin-face *m*. 2. Twin-face *e*. Cleavage. *e*, *n*. *n* more distinct than *e*; *c*, traces. Fracture imperfect conchoidal... uneven. Semi-transparent...translucent on the edges. Lustre vitreous, inclining to adamantine. R = 1·525. White passing into grey, yellow, brown, orange, red, green. Streak white. Brittle. H = 4·5. G = 5·9...6·22.

Melts with difficulty before the blowpipe into a transparent bead. With borax fuses into a transparent glass which, when perfectly saturated, becomes white and crystalline on cooling. With salt of phosphorus in the outer flame fuses into a clear colourless glass; in the inner flame into a glass which appears green while hot, and blue when cold. In powder is decomposed by hot hydrochloric or nitric acid, leaving a yellow residue of scheelic acid, which is soluble in ammonia. It is decomposed by potash, leaving a residue of lime. Scheelic acid is precipitated from the solution on the addition of an acid.

$\dot{Ca}\dddot{W}$, scheelic acid 81·00, lime 19·00.

Analyses of scheelite *a* from Westmanland by Berzelius, *b* from Schlackenwald by Brandes and Bucholz, *c* from Connecticut by Bowen, *d* from Llamuco by Domeyko, *e* from Katharinenburg, G = 6·071, by Choubine, *f* from Harzgerode by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*
Scheelic acid . .	80·42	78·00	76·05	75·75	78·41	78·64
Lime	19·40	19·06	19·36	18·05	18·88	21·56
Red ox. iron . .	—	—	1·03	$\dot{Cu}$ 3·30	—	—
Ox. mang. . . .	—	—	0·31	$\dot{Mg}$	0·65	—
Silica	—	2·00	2·54	0·75	—	—

In attached and imbedded crystals; occasionally massive.

Is found in the tin mines of Zinnwald and Schlackenwald in Bohemia, Ehrenfriedersdorf and Freiberg in Saxony, at St. Agnes in Cornwall, Caldbeck Fell in Cumberland, Monroe and

Huntingdon in Connecticut; in the gold mines of Schellgaden in Salzburg and Pösing in Hungary, Puy les Vignes near St. Leonard in La Haute Vienne in France, on the Pfaffenberg in the Harz, near Katharinenburg in Siberia, in the copper mine of Llamuco near Chuapa in the province of Coquimbo in Chile.

309. STOLZITE.—Tungstate of lead; Phillips. Plomb tungstaté; Dufrénoy. Dystomer Blei-Baryt; Mohs. Scheelbleispath; Hausmann. Stolzit; Haidinger.

Pyramidal. 101,001 = 57° 27′.

c 001, *e* 101, *m* 110, *v* 112, *n* 111, *o* 221. The forms *e*, *n* are sometimes hemihedral with inclined faces.

mc	90°	0′
mm′	90	0
vv′	63	19
vv″	95	51
ec	57	27
ee′	73	10
ee″	114	54
nn′	80	15
nn″	131	25
oc	77	17
oo′	87	13
oo″	154	34
om	12	43
ve	36	35

FIG. 476.

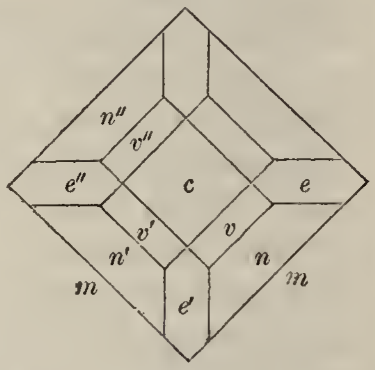
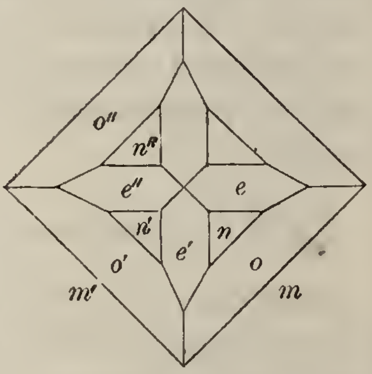


FIG. 477.



Forms and combinations. *o*, *cm*, *mo*, *n′e`*, *cmo*, *nemo*, *cmnev*. The faces *o*, *m* curved; *c*, rough. Cleavage. *n*, indistinct; *c*, rather more distinct. Fracture conchoidal. Semi-transparent… translucent on the edges. Lustre resinous. Grey, brown, yellow, green. Streak greyish-white. Brittle. H = 3·0. G = 7·9…8·09.

Melts before the blowpipe on charcoal, deposits a sublimate of oxide of lead on the charcoal, and leaves a dark crystalline bead. With borax in the outer flame fuses into a colourless glass; in the inner flame into a yellowish bead, which becomes grey and opaque on cooling. When by prolonged exposure to the blowpipe-flame all the lead is driven off, the bead becomes transparent and of a deep red colour on cooling. With salt of phosphorus in the outer flame forms a colourless glass; in the inner flame a blue glass. With soda yields globules of metallic lead. Is soluble in nitric acid, leaving a residue of scheelic acid. Soluble in potash.

$\dot{\mathrm{Pb}}\dddot{\mathrm{W}}$, oxide of lead 47·55, scheelic acid 52·45.

Analyses of stolzite from Zinnwald *a* by Lampadius, *b*, *c* by Kerndt:—

	a	*b*	*c*
Scheelic acid	51·75	51·44	52·04
Oxide of lead	48·25	47·12	44·86
Lime	—	1·26	1·53
Protoxides of iron and man.	—	0·31	0·63

Is found in small crystals with quartz and mica in the tin mines of Zinnwald in Bohemia.

310. WULFENITE.

—Molybdate of lead; Phillips. Plomb molybdaté; Hauy. Pyramidaler Blei-Baryt; Mohs. Bleigelb; Hausmann. Wulfenit; Haidinger.

Pyramidal. 101,001 = 57° 33′·5.

c 001, *a* 100, *m* 110, *g* 310, *f* 320, *q* 302, *e* 101, *y* 203, *u* 102, *t* 103, *r* 332, *n* 111, *s* 113, *h* 229, *w* 1 1 16. The forms *f*, *n*, *e* are sometimes hemihedral with inclined faces.

ga	18°	26′	*hh″*	52°	36′	*nn″*	131°	35′
fa	33	41	*ss′*	49	49	*rr′*	85	16
ma	45	0	*ss″*	73	7	*rr″*	146	38
aa′	90	0	*nn′*	80	20	*ne*	40	10
mm′	90	0						
fm	11	19						
gm	26	34						
ac	90	0						
tt′	38	21						
tt″	55	21						
uu′	51	51						
uu″	76	23						
yy′	61	34						
yy″	92	43						
ee′	73	16						
ee″	115	7						
qq′	81	14						
qq″	134	4						
ww′	11	12						
ww″	15	50						
hh′	36	31						

FIG. 478.

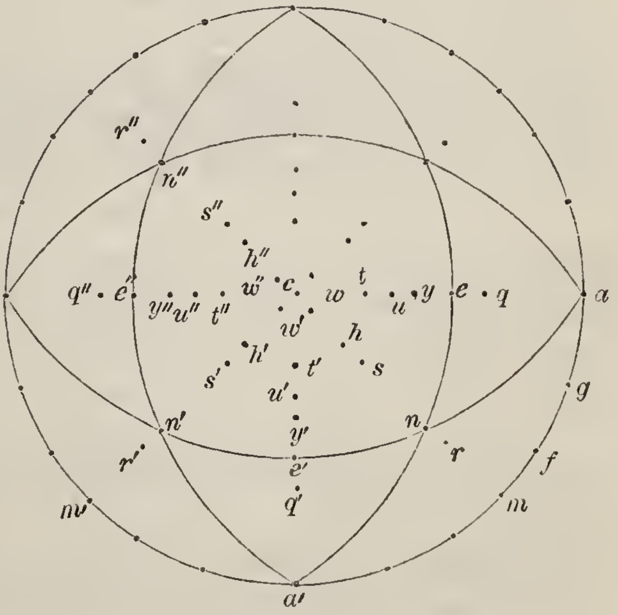


FIG. 479.

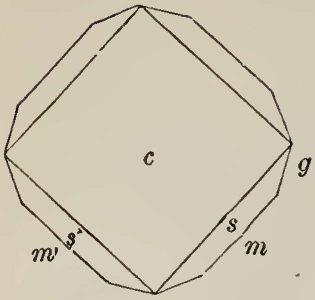


FIG. 480.

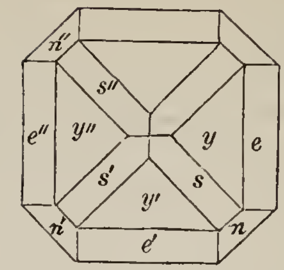
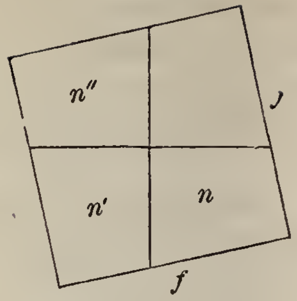


FIG. 481.



Form and combinations. *n*, *cn.m.s*, *cm.s.g*, *sy*, *cs.u*, *cmgs*, *nesy*, *ncmagswuq*, *nf'*, *n'e'*. The faces *c* striated parallel to its intersections with *n*; *e*, *a* rough; *m*, *f* smooth but curved. Cleavage. *n*, smooth, but frequently interrupted by conchoidal fracture; *c*, *s* less distinct, not always observable. Fracture conchoidal... uneven. Transparent...translucent on the edges. Lustre resinous. Colourless, yellow, green, red, grey, brown. Streak white. Brittle. H = 3·0. G = 6·3...6·9.

Decrepitates violently when heated, and becomes darker, recovering its colour on cooling. Melts before the blowpipe, on charcoal, and sinks into the charcoal, leaving globules of metallic lead on the surface. With borax in the outer flame forms a colourless glass; in the inner flame a glass which takes a dark brown colour on cooling. With salt of phosphorus forms a green glass, which, with a large quantity of the assay, becomes black and opaque. In powder is soluble in hot nitric acid, leaving a yellowish residue, which, spread on paper with an iron spatula, becomes blue. Is partially soluble in hydrochloric acid, leaving a residue of chloride of lead. The solution is green. Is decomposed by sulphuric acid, yielding a solution which in a certain state of concentration is blue.

$\dot{Pb}\dddot{Mo}$, molybdic acid 38·57, oxide of lead 61·43.

Analyses of wulfenite from Bleiberg *a* by Hatchett, *b* by Göbel, *c* by Melling, *d* from Chile by Domeyko, *e* by W. Parry, *f* from Zacatecas by C. Bergemann:—

	a	*b*	*c*	*d*	*e*	*f*
Molybdic acid	38·0	40·5	40·29	42·2	39·30	37·65
Oxide of lead	58·0	59·0	61·90	43·0	60·35	62·35
Red ox. iron	3·0	—	—	8·5	—	—
Lime	—	—	—	6·3	—	—

The red variety from Rezbanya contains a small quantity of chrome.

In crystals; massive; pseudomorphous after galena.

Is found in Carinthia, at Deutsch-Bleiberg, Windisch-Bleiberg, Schwarzenbach, Windisch-Kappel and some other places, Annaberg in Austria, Rezbanya in Hungary, Szaska in the Banat, Badenweiler in Baden, Mauknerötz in the Tyrol, Schneeberg and Johann-Georgenstadt in Saxony, Höllenthal near Werdenfels in Bavaria, in the lead mines of Southampton in Massachusetts, and of Perkiomen in Pennsylvania, Chile, Zimapan in Mexico, at a place five wersts south of the source of the Nura in the Kirghise steppes.

ARSENIATES, PHOSPHATES.

311. KÜHNITE.—Chaux arseniatée anhydre; Dufrénoy. Berzeliit; Hausmann. Berzelit; Haidinger.

Cleavage in one direction. Fracture uneven. Lustre waxy, yellowish-white, honey-yellow. Brittle. H = 5·0...6·0. G = 2·52.

Becomes grey before the blowpipe. Infusible. With soda yields the reaction of manganese. Soluble in nitric acid.

$\dot{R}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{As}$, where $\dot{R}$ is lime, magnesia and protoxide of manganese.

Analyses by Kühn:—

Arsenic acid	58·51	56·46
Lime	23·22	20·96
Magnesia	15·68	15·61
Protoxide of manganese	2·13	4·26
Loss by ignition	0·30	2·95
Insoluble	—	0·23

Is found in cleavable masses at Langbanshytta in Sweden.

312. MIMETITE.—Arseniate of lead; Phillips. Plomb arseniaté; Hauy. Brachytyper Blei-Baryt; Mohs. Mimetesit; Hausmann. Mimetit; Haidinger.

Rhombohedral. 100,111 = 56° 18′·5.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *r* 100, $r_{,}$ $\bar{1}22$, *x* 120, *z* $13\bar{1}$, *v* $15\bar{3}$.

ao	90°	0′	*xa*	49°	6′	$rr_{,}$	112°	37′
bo	90	0	*zo*	60	0	rr'	93	12
aa'	60	0	*za*	30	0	$r'r_{,}$	49	10
bb''	60	0	*vo*	73	54	ra'	43	24
ba'	30	0	*va*	16	6	xx'	38	12
xo	40	54	*ro*	56	19	xa'	70	54

xx''	69°	4'	*zz'*	51°	19'	*vv'*	57°	26'
xb'	55	28	*za'*	64	20	*va'*	61	17
zr'	25	40	*xz'*	48	35	*vz'*	56	19

FIG. 482.

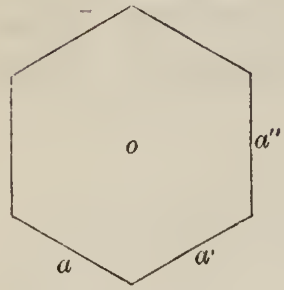


FIG. 483.

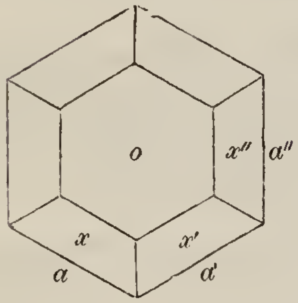
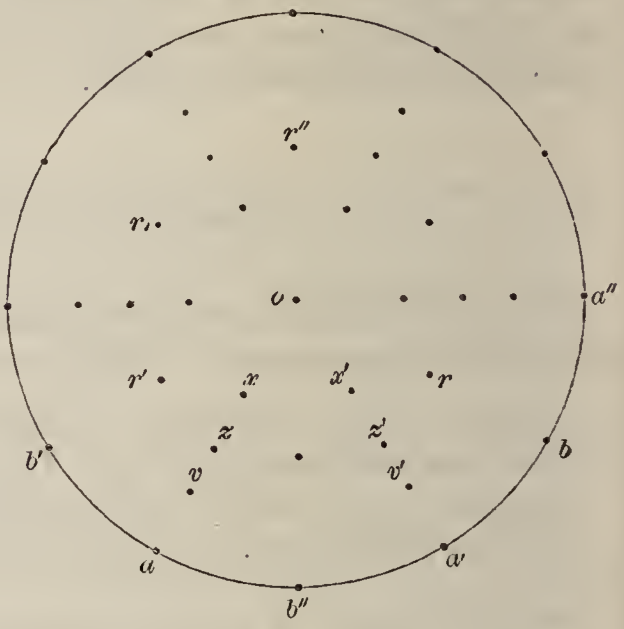


FIG. 484.



Combinations. *oa*, *ax*, *ox*, *oax*, *oabxrr,..v.z.* Cleavage. *x*, imperfect and interrupted. Fracture imperfect conchoidal... uneven. Translucent. Lustre resinous. Siskin-green...wax-yellow...straw-yellow. Streak white. Brittle. H = 3·5...4·0. G = 7·18...7·28.

Before the blowpipe on charcoal emits fumes of arsenic, and yields a globule of lead. When melted in the forceps it crystallizes in cooling. Soluble in nitric acid.

$\text{Pb}\,\text{Cl} + 3\dot{\text{Pb}}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\text{As}}$, arsenic acid 23·69, oxide of lead 66·76, chlorine 2·44, lead 7·11.

Analysis of mimetite from Johann-Georgenstadt by Wöhler:—

Arseniate of oxide of lead	82·74
Phosphate of oxide of lead	7·50
Chloride of lead	9·60

Analysis of mimetite from Zacatecas by C. Bergemann:—

Arsenic acid	23·07
Chlorine	2·45
Oxide of lead	66·95
Lead	7·14

In attached crystals; reniform; compact; earthy. Occurs usually in veins of galena.

Is found at Johann-Georgenstadt in Saxony, Hausbaden near Badenweiler in Baden, in the mines of Huel Gorland, Huel Alfred and Huel Unity in Cornwall, Beeralston in Devonshire, Caldbeck Fell in Cumberland, St. Prix in France in yellow silky fibres, and has been called arsenite, Nertschinsk.

Breithaupt's hedyphane from Langbanshytta is a massive variety of mimetite cleavable parallel to *o*, *x*. Greyish-white, H = 3·5…4·0. G = 5·460…5·493. According to Kersten, it consists of—arseniate of oxide of lead 60·10, arseniate of lime 12·98, phosphate of lime 15·51, chloride of lead 10·29.

313. PYROMORPHITE.—Phosphate of lead; Phillips. Plomb phosphaté; Hauy. Rhomboedrischer Blei-Baryt; Mohs. Pyromorphit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 55° 49′.

o 111, a $01\bar{1}$, b $2\bar{1}\bar{1}$, r 100, $r_{,}$ $\bar{1}22$, x 120, z $13\bar{1}$, v $15\bar{3}$.

ao	90°	0′	va	16°	23′	xb'	55°	53′
bo	90	0	ro	55	49	zr'	25	32
aa'	60	0	$or_{,}$	55	49	zz'	51	4
bb''	60	0	$rr_{,}$	111	38	za'	64	28
ba'	30	0	rr'	91	32	xz'	48	17
xo	40	22	$r'r_{,}$	48	52	vv'	57	20
xa	49	38	ra'	44	14	va'	61	20
zo	59	32	xx'	37	48	vz'	56	11
za	30	28	xa'	71	6			
vo	73	37	xx''	68	14			

FIG. 485.

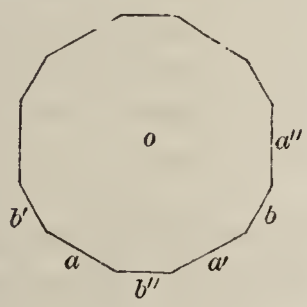
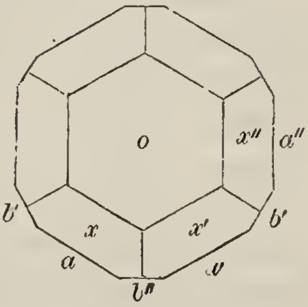


FIG. 486.



See also figs. 482, 483, 484.

Combinations. *oa*, *ox*, *ax*, *az*, *oax*, *oab*, *oabx*, $oaxrr_{,}$. The faces *a* usually striated parallel to their intersections with *o*;

o, rough, frequently concave. Cleavage. *x*, imperfect and interrupted; *a*, hardly perceptible. Fracture imperfect conchoidal. Semi-transparent...translucent on the edges. Lustre resinous, in the brown varieties inclining to adamantine. Green, brown, yellow, grey of various shades. Streak white, sometimes inclining to yellow. Brittle. H = 3·5...4·0. G = 6·9...7·1.

Melts readily before the blowpipe on charcoal, and the bead crystallizes in cooling. With boracic acid and iron wire yields phosphide of iron and metallic lead. With soda on charcoal the lead is reduced. Soluble in nitric acid. The solution yields a precipitate with nitrate of silver.

$\dot{Pb}Cl + 3\dot{Pb}^3\overset{.....}{P}$, phosphoric acid 15·77, oxide of lead 73·99, chlorine 2·62, lead 7·62. Part of the phosphoric acid is sometimes replaced by arsenic acid. Small quantities of lead and chlorine are also replaced by calcium and fluorine.

Analyses of pyromorphite *a* from Mies, *b* from Bleistadt, *c* from England, *d*, *e* from Poullaouen, all by Kersten, *f* from Bleiberg by Bergemann:—

	a	*b*	*c*	*d*	*e*	*f*
Phosph. ox. lead . .	89·27	89·17	89·11	89·91	89·93	92·55
Phosph. lime . . .	0·85	0·77	0·68	—	—	—
Chlor. lead . . .	9·66	9·92	10·07	10·09	10·07	7·45
Fluor. calc. . . .	0·22	0·14	0·13	—	—	—

Analyses of pyromorphite *g*, *h* from Bleistadt by Lerch, *i*, *k* from Zschopau, *l* from Leadhills, all by Wöhler, *m* from Krausberg by Sandberger:—

	g	*h*	*i*	*k*	*l*	*m*
Phosph. ox. lead . .	87·38	88·42	80·37	89·94	88·16	89·43
Ars. ox. lead . . .	—	—	9·01	—	—	—
Phosph. lime . . .	0·86	1·58	—	—	—	—
Phosph. $\dot{Fe}$	0·77	0·50	—	—	—	—
Chlor. lead	10·23	9·57	10·09	10·05	9·91	10·24
Fluor. calc. . . .	0·07	0·20	—	—	—	—

Pyromorphite from Clausthal and from Hofsgrund in the Breisgau contains a small quantity of silver. Pyromorphite from Beresowsk contains chrome.

In attached crystals; massive; reniform; pseudomorphous after galena and cerussite. Occurs in veins containing galena, to the decomposition of which it is supposed to owe its origin.

Is found at Przibram, Mies and Bleistadt in Bohemia, Zschopau, Freiberg and Johann-Georgenstadt in Saxony, Wolfach and Hofsgrund in Baden, Galgenberg near Clausthal, and Bleifeld near Zellerfeld in the Harz, Poullaouen, Huelgoët, Pontgibaud, and fibrous at St. Prix in France, Hodritsch near Schemnitz in Hungary, Beresowsk and Katharinenburg in Siberia, Cornwall, Cumberland, Durham, Yorkshire, Derbyshire in England, Wanlockhead and Leadhills in Scotland.

Breithaupt's polysphærite and miesite from the Sonnenwirbel mine near Freiberg, and Mies in Bohemia, are varieties of pyromorphite, in which part of the oxide of lead is replaced by lime. They occur usually in reniform and botryoidal masses, sometimes in crystals showing the forms *o*, *a*. H = 3·0...3·5. G = 5·89...6·45.

Analyses by Kersten:—

Phosphate of oxide of lead . . .	77·02	81·65
Phosphate of lime	11·05	7·46
Chloride of lead	10·84	10·64
Fluoride of calcium	1·09	0·25

314. APATITE.—Apatite; Phillips. Chaux phosphaté; Hauy. Rhomboedrisches Fluss-Haloid; Mohs. Apatit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 55° 40′.

o 111, a $01\bar{1}$, b $2\bar{1}\bar{1}$, h $3\bar{1}\bar{2}$, k $5\bar{1}\bar{4}$, r 100, $r_,$ $\bar{1}22$, e 011, $e_,$ 411, s $\bar{1}11$, $s_,$ $5\bar{1}\bar{1}$, i 231, x 120, z $13\bar{1}$, u 041, $u_,$ 232, t $05\bar{2}$, $t_,$ $34\bar{2}$, d $16\bar{1}$, $d_,$ $35\bar{2}$. The forms h, k, u, $u_,$, t, $t_,$, d, $d_,$ are hemihedral with parallel faces.

ao	90°	0′	za	30°	36′	uo	69°	57′
bo	90	0	eo	36	13	$ou_,$	69	57
ad'	60	0	$ee_,$	72	25	to	75	0
bb''	60	0	$e'e_,$	34	21	$ot_,$	75	0
ba'	30	0	ro	55	40	do	56	44
hb	10	54	$rr_,$	111	20	$od_,$	56	44
kb	19	6	rr'	91	18	ii'	22	27
io	22	55	$r'r_,$	48	46	xx'	37	40
ia	67	5	ra'	44	21	zz'	50	59
xo	40	13	so	71	9	ua	30	23
xa	49	47	$ss_,$	142	18	ta	22	44
zo	59	24	$s's_,$	56	29	da	35	45

FIG. 487.

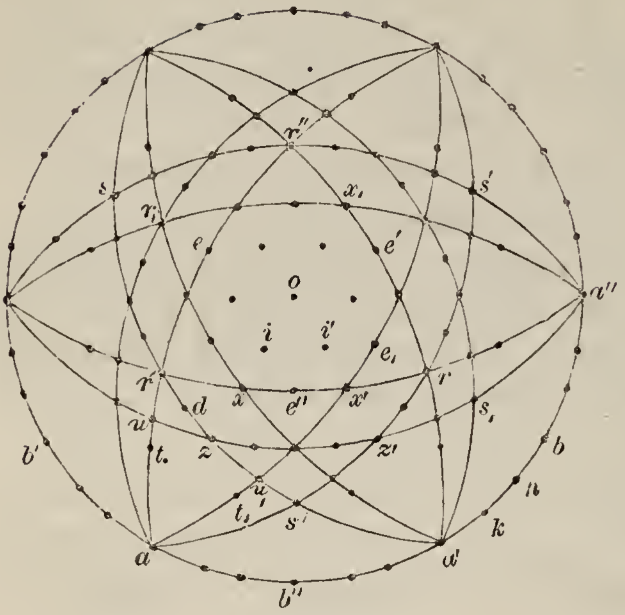


FIG. 488.

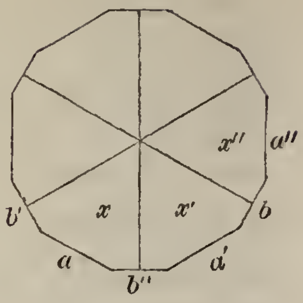


FIG. 489.

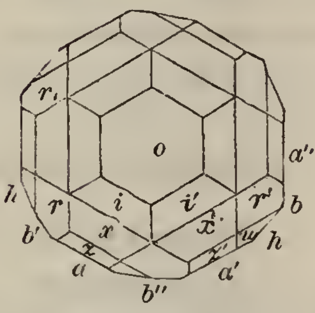
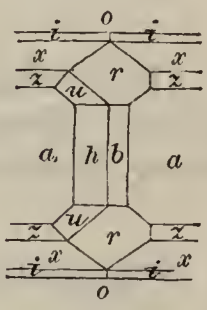


FIG. 490.



Combinations. *oa*, *oab*, *ax*, *abx*, *airr,*, *oarr,*, *oai*, *oaxrr,*, *oabizrr,*, *oxizee,rr,ss,*, *oabixrr,t`t`,*, *oabxzee,rr,h`u`u`,*, *oabxziee,rr,u`u,`t`t,`*, *oaxzee,r-r,u`u,`h`k′*, *oabxiee,rr,u`u,`d`d,`*. Cleavage. *o*, *a*, both imperfect, *a* more easily obtained than *o*. Fracture conchoidal, more or less perfect, uneven. Transparent...translucent. Lustre vitreous, inclining to resinous. Colourless, white, grey, blue, green, yellow, red, brown. Dichromatic. Streak white. Brittle. H = 5·0. G = 3·18...3·21.

In very thin splinters is fusible with difficulty before the blowpipe into a colourless transparent glass. With borax is dissolved slowly into a clear glass, which may be rendered opaque by an intermitting flame. Soluble in salt of phosphorus, forming a clear bead, which, when saturated with the assay, becomes opaque on cooling, and shows crystalline facets. Soluble with difficulty in boracic acid; with iron wire yields a phosphide of iron. Moistened with sulphuric acid it imparts a green colour to the flame. With salt of phosphorus and oxide of copper yields the reaction of chlorine. With salt of phosphorus in the open tube, or with sulphuric acid, gives indications of fluorine. Soluble without effervescence in hydrochloric acid, and in nitric acid. The solution in nitric acid of the varieties containing chlorine gives a precipitate with nitrate of silver. Some varieties phosphoresce when heated; others when rubbed.

$\mathrm{Ca\,Fl} + 3\dot{\mathrm{C}}\mathrm{a}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, phosphoric acid 42·38, lime 49·92, fluorine 3·74, calcium 3·96. Part of the fluorine is frequently replaced by chlorine.

Analyses of apatite *a* from Spain, *b* from Arendal, *c* from the Greiner, *d* from Faltigl, *e* from St. Gotthard, *f* from Snarum, all by G. Rose:—

	a	*b*	*c*	*d*	*e*	*f*
Phos. ac., fl., loss . .	44·27	43·72	44·35	44·08	44·32	42·90
Hydrochloric acid .	0·43	0·39	0·07	0·05	0·02	2·10
Lime	55·30	55·89	55·57	55·87	55·66	54·75
Red ox. iron . . .	—	—	—	—	—	0·25

Rammelsberg obtained from crystallized apatite from Schwarzenstein in the Zillerthal—lime 55·31, chlorine 0·07, and in three different analyses—fluorine 0·64, 0·52, 0·93, the quantity of fluorine required by the formula being 3·63. He considers it uncertain whether the difference is attributable to a defect in the method of determining the fluorine (Wöhler's), or to an error in the formula. G. Bischof found small quantities of magnesia in apatite from Ehrenfriedersdorf, Schlackenwald, the lake of Laach, Estremadura, &c.

Analyses of apatite *g*, *h* from Wheal Franco near Tavistock (francolite) by T. H. Henry, *i* from Snarum, mean of three analyses by R. Weber:—

	g	*h*	*i*
Phosphoric acid	41·34	41·80	41·54
Lime	53·38	52·81	53·46
Ox. iron and man. . . .	2·96	3·22	& $\dot{\mathrm{Y}}$ 1·79
Fluorine and loss	2·32	2·17	not det.
Chlorine	—	—	2·66

In attached and imbedded crystals; massive; earthy. In granite, gneiss, mica slate, talk slate, hornblende slate, marble, dolerite, basalt, in veins of tin ore and in beds of iron ore.

Is found at Jumilla in Murcia in Spain, St. Gotthardt, the valleys of Maggia and Tavetsch, imbedded in chlorite in the Zillerthal in the Tyrol, in the tin mines of Zinnwald and Schlackenwald in Bohemia, and Ehrenfriedersdorf in Saxony, St. Michael's Mount, St. Agnes and the cliffs of Botallack near the Land's End in Cornwall, in granite at Bovey Tracy in Devonshire, at Caldbeck Fell in Cumberland, in beds of iron ore at Arendal, and in mica slate at Snarum in Norway, in crystals with rounded edges in granular limestone at Pargas in

Finland, at Hammond in New York, Westmoreland in New Hampshire, and many other places in the United States. A massive, highly phosphorescent variety (phosphorite) is found at Logrosa near Truxillo in Estremadura, consisting, according to the analysis by Daubeny, of phosphate of lime 81·15, fluoride of calcium 14·00, red oxide of iron 3·15, silica 1·70. Massive apatite is also found at Arendal, containing acicular crystals of cryptolite, Greenland, Amberg in Bavaria, Schlackenwald in Bohemia. Earthy varieties are found at Szigeth in Hungary, Marienberg in Saxony, Fuchsmahl in Bavaria, Vitteaux in France. A variety of apatite, having the forms *o*, *a*, from Kusiusk in the district of Slatoust in the Ural, according to the analysis of Hermann, contains 7·74 per cent. of magnesia.

G. Rose found the angle *xo* of apatite from various localities to vary as follows:—

Lake of Laach	40°	6′
Spain	40	14
St. Gotthardt	40	17
Ehrenfriedersdorf	40	18·5

315. ZWISELITE.—Eisenapatit; Hausmann. Zwiselit; Haidinger.

Prismatic.

Cleavage in one direction perfect; indistinct in several directions perpendicular to the former. Fracture imperfect conchoidal...uneven. Translucent on the edges. Lustre resinous. Clove-brown. Streak greyish-white. H = 5·0. G = 3·97.

Decrepitates when heated. Melts very easily before the blowpipe into a blackish-blue magnetic globule. With fluxes yields the reactions of iron and manganese. Soluble in hot hydrochloric acid. With concentrated sulphuric acid yields hydrofluoric acid.

$R\mathrm{Fl} + \dot{R}\overset{\cdot\cdot\cdot\cdot\cdot}{P}$, where R is Fe and Mn.

Analyses *a* by Fuchs, *b*, *c* by Rammelsberg:—

	a	*b*	*c*
Phosphoric acid	35·60	not det.	30·33
Protoxide of iron	35·44	40·90	41·42
Protoxide of mangan. . .	20·34	24·33	23·25
Fluorine	3·18	not det.	6·00
Iron	4·76	—	—
Silica	0·68	—	—

Is found in crystalline masses at Zwisel near Bodenmais in Bavaria.

316. WAGNERITE.—Wagnerite; Beudant. Hemiprismatischer Dystom-Spath; Mohs. Wagnerit; Hausmann, Haidinger.

Oblique. 101,100 = 63° 25′; 111,010 = 56° 3′; 101,001 = 44° 42′.

a 100, *c* 001, *w* 101, *g* 120, *m* 110, *h* 320, *l* 210, *e* 021, *f* 032, *r* 011, *t* 012, *z* 111, *i* 122, *x* 212, *n* 112, *d* 314, *s* 1̄11, *v* 1̄22, *o* 2̄21.

ca	108°	7′	*sa*	132°	41′	*xx′*	142°	48′
ca′	71	53	*va*	120	37	*nn′*	138	54
wa	63	25	*ra*	104	39	*ii′*	106	4
wc	44	42	*ia*	86	3	*dd′*	159	10
gg′	57	35	*za*	68	13	*vv′*	119	0
mm′	95	25	*ta*	107	2	*ss′*	127	32
hh′	117	32	*na*	94	38	*oo′*	111	42
ll′	131	4	*xa*	64	54	*rz*	36	27
ee′	69	54	*oa*	137	39	*rz′*	98	53
ff′	85	58	*ea*	100	16	*tx*	42	8
rr′	108	50	*zw*	33	57	*tx′*	121	47
tt′	140	38	*zz′*	112	6	*wm*	70	40
dw	14	26	*xw*	18	36	*wg*	77	33
nw	29	30						
rw	54	41						
mw	70	40						

FIG. 491.

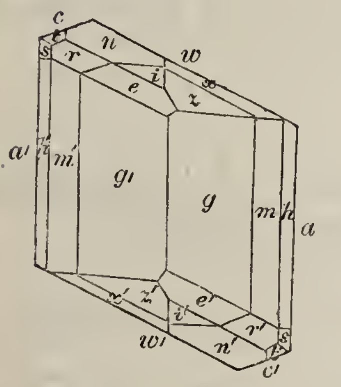
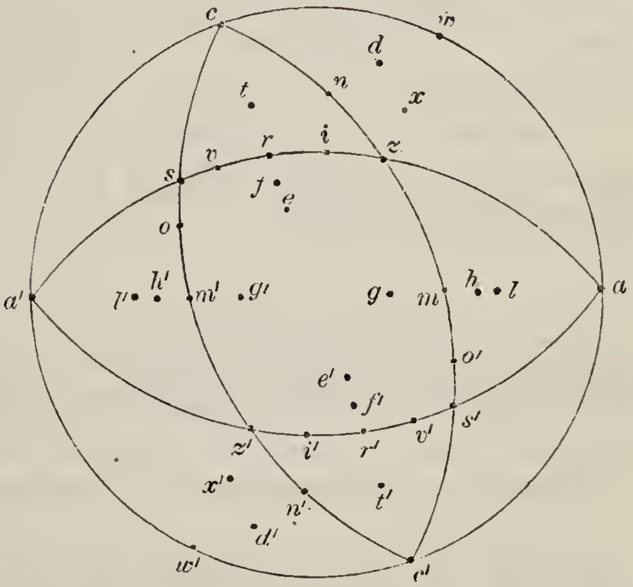


FIG. 492.



Combinations. *wxnrziegmha.ctsovld.* The faces *a*, *l*, *h*, *m* are striated parallel to their intersections with each other.

Cleavage. *g*, imperfect; *a*, *c*, traces. Fracture conchoidal. Transparent...translucent. Lustre vitreous. Wine-yellow... orange-yellow, inclining to grey. Streak white. Brittle. H = 5·0...5·5. G = 2·98...3·13.

In thin splinters melts with great difficulty before the blowpipe into a dark greenish-grey glass. Moistened with sulphuric acid it imparts a faint blueish-green colour to the flame. Is soluble in powder in hot nitric or sulphuric acid with evolution of hydrofluoric acid.

$MgF + \dot{M}g^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$, phosphoric acid 43·32, magnesia 37·57, fluorine 11·45, magnesium 7·66. Part of the magnesia is replaced by lime and protoxide of iron.

Analyses of wagnerite *a* by Fuchs corrected by Rammelsberg, *b*, *c*, *d* by Rammelsberg, *e* the result of *d*, the best of the analyses *b*, *c*, *d*, after excluding the silica:—

	a	*b*	*c*	*d*	*e*
Phosphoric acid . . .	41·73	41·89	40·23	39·56	40·61
Magnesia	46·66	42·04	38·49	45·07	46·27
Lime	—	1·65	4·40	2·32	2·38
Protox. iron	4·50	2·72	3·31	4·47	4·59
Oxide of mangan. . .	0·50	—	—	—	—
Alumina	—	0·55	0·96	—	—
Fluorine	13·1	not det.		9·12	9·36
Silica	—	—	—	2·68	—

This extremely rare mineral was found in crystals with quartz, in the crevices of a clay slate rock, in the valley of Höllengraben near Werfen in Salzburg.

A crystal in Mr. Brooke's collection shows all the faces enumerated above, of which *l*, *d*, *o*, *f* appear to have been hitherto overlooked.

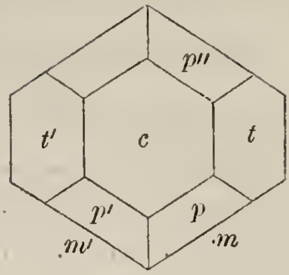
317. HERDERITE.—Herderite; Dufrénoy. Prismatisches Fluss-Haloid; Mohs. Herderit; Hausmann, Haidinger.

Prismatic. 011,010=55° 51′; 101,001=23° 1′; 110,100=57° 56′·5.

a 100, *b* 010 cleavage, *c* 001, *t* 302, *s* 601, *m* 110, *p* 111, *n* 331, *o* 441. The faces *a*, *s* truncate the edge formed by *t* and the face parallel to *t′*; *n*, *o* truncate the edge *pm*; *b* truncates the edge *mm′*.

bc	90°	0′	*pc*	38°	41′
ca	90	0	*pm*	51	19
ab	90	0	*nn′*	58	41
tt′	65	0	*nn″*	102	57
sc	68	34	*nc*	67	25
sa	21	26	*oo′*	60	53
mm′	64	7	*oo″*	110	6
pp′	38	43	*oc*	72	39
pp″	63	57			

FIG. 493.



Combinations. *mptc*, *monptsac*. Cleavage. *m*, interrupted; *b*, imperfect; *c*, traces. Fracture conchoidal. Transparent. Lustre vitreous, inclining to resinous. Yellowish and greenish-white. Streak white. Very brittle. H = 5·0. G = 2·985…2·990.

Melts with difficulty before the blowpipe into a white enamel. Moistened with sulphuric acid imparts a green colour to the flame. With boracic acid and iron wire on charcoal yields a bead of phosphide of iron. With solution of cobalt becomes blue. In very fine powder is perfectly soluble in hot hydrochloric acid.

According to Plattner, consists of anhydrous phosphate of alumina, phosphate of lime and hydrofluoric acid.

Herderite occurs in crystals which resemble very closely the variety of apatite called asparagus stone. It is very rarely found in the tin-mines of Ehrenfriedersdorf in Saxony.

318. AMBLYGONITE.—Amblygonite; Phillips, Beudant. Prismatischer Amblygon-Spath; Mohs. Amblygonit; Hausmann, Haidinger.

Prismatic.

Cleavage tolerably perfect in two directions, making with each other an angle of 106° 10′, and imperfectly in a third direction parallel to the intersection of the two former, and making with them angles of 53° 5′. Fracture uneven and splintery. Semi-transparent…translucent. Lustre vitreous; on the planes of most perfect cleavage pearly; on surfaces of fracture resinous. Greyish and greenish-white, mountain-green, celadon-green. Streak white. H = 6·0. G = 3·045…3·110.

In the matrass, in a strong heat, yields moisture which acts upon the glass. Melts very easily before the blowpipe into a clear glass, which becomes opaque on cooling. Moistened with sulphuric acid it imparts a blueish-green colour to the flame.

In fine powder is soluble with difficulty in hydrochloric acid, more easily in sulphuric acid.

Analyses of amblygonite from Arnsdorf by Rammelsberg:—

Phosphoric acid . . .	48·00	47·15	—	—	—
Alumina	36·26	38·43	36·62	36·89	—
Lithia	6·33	7·03	—	—	—
Soda	5·48	3·29	—	—	—
Potash	—	0·43	—	—	—
Fluorine	—	—	—	—	8·11

Is found in crystalline masses, with tourmaline and topaz, in granite at Chursdorf and Arnsdorf near Penig in Saxony, and at Arendal in Norway.

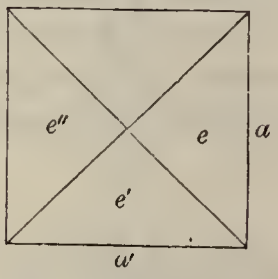
319. XENOTIME.—Phosphate of yttria; Phillips. Xenotime; Beudant. Pyramidaler Retin-Baryt; Mohs. Ytterspath; Hausmann. Xenotim; Haidinger.

Pyramidal. 101,001 = 41° 0′.

a 100, *e* 101.

aa′	90° 0′	*ee′*	55° 17′
ea	49 0	*ee″*	82 0

FIG. 494.



Combination. *ea*. Cleavage. *a*. Fracture splintery...uneven. Translucent...translucent on the edges. Lustre resinous. Brown and red of various shades. Streak light brown. Brittle. H = 4·5...5·0. G = 4·39...4·557.

Infusible before the blowpipe. With borax melts into a colourless bead, which becomes milky on cooling. Soluble with difficulty in salt of phosphorus, forming a colourless glass. With boracic acid and iron wire yields phosphide of iron. Insoluble in acids.

$\dot{Y}^3\overset{.....}{P}$, phosphoric acid 37·17, yttria 62·83.

Analysis of xenotime from Norway by Berzelius:—

Phosphoric acid with traces of hydrofluoric acid .	33·49
Yttria	62·58
Basic phosphate of protoxide of iron	3·93

According to Scheerer, xenotime from Norway contains:—

Phosphoric acid and silica	32
Yttria and red oxide of iron	68

In crystals; massive; disseminated.

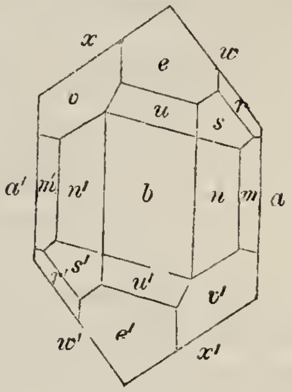
Is found in granite in the island of Hitteröe near Fleckefjord in Norway, and at Ytterby in Sweden.

320. MONAZITE. — Monazite; Breithaupt, Dufrénoy. Mengite; Brooke, Phil. Mag. 1831. x. 139. Edwardsite, Eremite; Shepard. Sillim. Journ. xxxii. 162. 341. Monazit; Mohs, Haidinger, Hausmann.

Oblique. 101,001 = 36° 54′; 101,100 = 39° 20′; 111,010 = 59° 41′.

a 100, *b* 010, *c* 001 cleavage, *e* 011, *u* 021, *w* 101, *x* 10$\bar{1}$, *m* 110, *n* 120, *r* 111, *s* 121, *v* $\bar{1}$11.

FIG. 495.



ab	90°	0′	*ee*′	96°	16′
cb	90	0	*uu*′	58	18
ac	76	14	*mm*′	93	10
wa	39	20	*nn*′	55	42
xa′	53	52	*rr*′	119	22
wc	36	54	*ss*′	81	4
xc	49	54	*vv*′	106	36

Combinations. *abwxem..n.v*, *abwxeurv*, *abwxemnvrus*. Cleavage. *c*, more or less perfect; *a*, *b*, imperfect. Fracture uneven. Semi-transparent… translucent on the edges. Lustre resinous. Reddish-brown… hyacinth-red. Streak reddish-yellow. H = 5·5. G = 4·8…5·0.

Fusible with difficulty on the edges before the blowpipe. When moistened with sulphuric acid imparts a green colour to the flame. With borax or salt of phosphorus melts into a transparent glass, which is yellowish-red while hot, but becomes colourless on cooling. Is decomposed by hydrochloric acid.

Analyses of monazite from the Ural by Kersten and Hermann:—

Phosphoric acid	28·50	28·05
Protoxide of cerium . . .	26·00	37·36
Oxide of lanthanium . . .	23·40	27·41
Thorine	17·95	—
Lime	1·68	1·46
Magnesia	—	0·80
Oxide of tin	2·10	1·75
Protoxide of mangan. . . .	1·86	trace
Potash and titanic acid . .	traces	—

The presence of thorine in monazite from the Ural has been confirmed by Wöhler.

Is found in small crystals imbedded in a mixture of felspar, albite and mica in the Ilmen mountains near Miask in Siberia; in the United States at Norwich, Chester, Watertown in Connecticut, and Yorktown in New York.

When Mr. Brooke described and gave the name of mengite to this mineral, he was not aware of its having been previously described by M. Breithaupt as monazite.

321. KRYPTOLITE.—Kryptolith; Wöhler, Hausmann.

In transparent, pale wine-yellow acicular crystals which, under the microscope, appear to be six-sided prisms. G = 4·6.

Unchanged at a moderate red heat. In fine powder completely decomposed by warm hydrochloric acid.

Analysis by Wöhler:—

Oxide of cerium	73·70
Protoxide of iron	1·51
Phosphoric acid	27·37

The excess is obviously occasioned by the higher oxidation of the cerium, which, as the colour of the mineral shows, must exist in it in the state of protoxide. It is probable that the supposed oxide of cerium may contain a mixture of the oxides of didymium and lanthanium.

Kryptolite occurs in parallel, acicular crystals, entirely imbedded in massive apatite at Arendal in Norway. They are obtained by dissolving lumps of the apatite in dilute nitric acid, which does not attack the kryptolite. The crystals are usually intermingled with particles of magnetite, amphibole and a hyacinth-red mineral which Wöhler supposes to be monazite.

322. TRIPHYLINE.—Triphyllin; Mohs, Hausmann, Haidinger.

Oblique.

b 010, *c* 001, *e* 101, *d* $\bar{1}01$, *m* 110.

bc	90° 0′	*mm′*	132° 0′
mb	66 0	*mbc*	90 0 nearly

Combination. *bcedm.* Cleavage. *m*, *b* imperfect; *c*, very perfect. Fracture imperfect conchoidal. Translucent on the edges. Lustre resinous, inclining to pearly on the surface of perfect cleavage. Greenish-grey, spotted with blue. Streak greyish-white. H = 5·0. G = 3·6.

Decrepitates when heated. Melts very easily before the blowpipe into a dark grey, magnetic bead, imparting a blueish-green, and sometimes a red colour to the flame. With soda on platinum foil yields the reaction of manganese; with borax, that of iron. Is easily dissolved in hydrochloric acid. The solution, evaporated to dryness and mixed with alcohol, burns with a purple flame.

$\dot{\mathrm{L}}\mathrm{i}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}} + 6\dot{\mathrm{F}}\mathrm{e}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, phosphoric acid 42·6, protoxide of iron 53·91, lithia 3·45. Part of the protoxide of iron is replaced by protoxide of manganese.

Analyses by Fuchs and Baer:—

Phosphoric acid	41·47	36·36
Protoxide of iron	48·57	44·52
Protoxide of manganese	4·70	5·76
Lime	—	1·00
Magnesia	—	0·73
Soda	—	5·16
Lithia	3·40	5·09
Potash	—	1·19
Silica	0·53	1·78
Water	0·68	—

It decomposes gradually, combining with water and parting with the lithia, while the protoxides of iron and manganese are converted into peroxides.

Is found in crystals, the surfaces of which are decomposed, and cleavable masses, at Rabenstein near Bodenmais in Bavaria, in granite, accompanied by beryl, crystals of which appear to be imbedded in it.

Tetraphyline from Keiti in the parish of Tammela in Finland is perhaps a variety of triphylin. A newly fractured surface is yellow, but on exposure becomes black. According to an approximate analysis by Berzelius and Nordenskiöld, it consists of phosphoric acid 42·6, protoxide of iron 38·6, protoxide of manganese 12·1, lithia 8·2, magnesia 1·7.

323. TRIPLITE.—Phosphate of manganese; Phillips. Triplite; Beudant. Prismatischer Retin-Baryt; Mohs. Triplit; Hausmann, Haidinger.

Prismatic.

Cleavage in three directions, making right angles with each other; one distinct, the other less distinct, and the third imperfect. Fracture imperfect conchoidal. Translucent on the edges...opaque. Lustre resinous. Brownish-black. Streak yellowish-grey. Brittle. H = 5·0...5·5. G = 3·6...3·8.

In the matrass yields traces of hydrofluoric acid. Melts very easily before the blowpipe, with intumescence, into an iron-black magnetic globule. With borax in the outer flame forms a purple glass, in the inner flame a green glass. With soda on platinum foil yields the reaction of manganese. With boracic acid and iron wire yields a bead of phosphide of iron. Is readily soluble in hydrochloric acid.

$\dot{\mathrm{Fe}}^4\overset{.....}{\mathrm{P}} + \dot{\mathrm{Mn}}^4\overset{.....}{\mathrm{P}}$, phosphoric acid 33·26, protoxide of iron 33·58, protoxide of manganese 33·16.

Analysis of triplite from Limoges by Berzelius:—

Phosphoric acid	32·8
Protoxide of iron	31·9
Protoxide of manganese . . .	32·6
Phosphate of lime	3·2

Is found in crystalline masses at Limoges in France, Washington, and Sterling in the United States.

HYDROUS ARSENIATES AND PHOSPHATES.

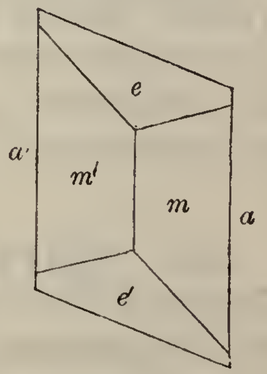
324. HUREAULITE.—Hureaulite; Beudant. Huraulit; Mohs. Hureaulit; Hausmann. Hureaulith; Haidinger.

Oblique. 101,100 = 42° 43′; 111,010 = 52° 50′; 101,001 = 25° 14′.

a 100, *e* 011, *m* 110.

ma	58° 45′	*ea*	74° 53′
mm′	62 30	*em*	63 3
ee′	88 0		

FIG. 496.



Combinations. *em*, *ema*. The faces *m* striated parallel to their intersections with each other. No cleavage observable. Fracture conchoidal. Transparent. Lustre vitreous. Yellowish-red, reddish-brown. H = 5·0. G = 2·270.

In the matrass yields water. Melts before the blowpipe into a black globule having a metallic lustre. Soluble in hydrochloric acid.

$\dot{R}^5\overset{.....}{P} + 8\dot{H}$, where $\dot{R}$ is $\dot{M}n, \dot{F}e$.

Analysis by Dufrénoy :—

Phosphoric acid	38·00
Protoxide of manganese	32·85
Protoxide of iron	11·10
Water	18·00

Is found in crystals and granular or columnar nodules, having a drusy surface, in geodes and small veins in the granite of Hureault not far from Limoges in France.

325. HETEROSITE.—Heterozite ; Mohs, Beudant. Heterosit ; Hausmann, Haidinger.

Oblique.

Cleavage in two directions, making with each other an angle of between 79° and 80°. Fracture uneven. Translucent on the edges...opaque. Lustre resinous on the cleavages ; dull on the surfaces of fracture. Greenish-grey, inclining to blue ; after exposure to the air changes to violet. Streak violet...red. H = 4·5...5·5. G = 3·524.

In the matrass yields water. Melts before the blowpipe into a dark brown, bright magnetic globule. With boracic acid and iron wire yields a bead of phosphuret of iron. Soluble in hydrochloric acid.

$\dot{R}^5\overset{.....}{P} + 2\dot{H}$, where $\dot{R}$ denotes $\dot{F}e$ and $\dot{M}n$.

Analysis by Dufrénoy :—

Phosphoric acid	41·77
Protoxide of iron	34·89
Protoxide of manganese	17·57
Water	4·40
Silica	0·22

After exposure to the air it cleaves more readily, and acquires a lustre inclining to metallic. H becomes 3·0 and G = 3·39.

Is found in granular masses in the granite of Hureault near Limoges in France.

326. DUFRENITE.—Phosphate de fer ; Beudant. Grüneisenstein ; Mohs, Hausmann. Dufrenit ; Haidinger.

Prismatic.

Cleavage in one direction. Transparent...opaque. Lustre vitreous, inclining to resinous. Green. Streak light green. Brittle. H = 4·0. G = 3·50...3·55.

In the matrass yields water. Melts readily before the blowpipe into a black porous globule, which is not magnetic. Is soluble in hydrochloric acid.

Analyses of dufrenite *a* from Sayn by Karsten, *b* from Haute Vienne (alluaudite) by Vauquelin, *c* from Hollerter Zug in Siegen by Schnabel:—

	a	*b*	*c*
Phosphoric acid	27·72	27·85	28·39
Red oxide of iron	63·45	56·20	53·66
Oxide of manganese . . .	—	6·76	—
Protoxide	—	—	9·97
Water	8·56	9·29	8·97

Is found in globular, botryoidal, reniform and fibrous masses, at Siegen, Hirschberg in Reuss, and Limoges in France.

Rammelsberg supposes it to result from $2\dot{\mathrm{F}}\mathrm{e}^4\overset{.....}{\overline{\mathrm{P}}}\mathrm{h} + \dot{\mathrm{H}}^5$, by the conversion of part of the protoxide of iron into red oxide.

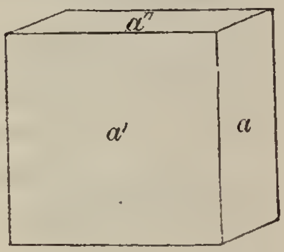
327. PHARMACOSIDERITE.—Arseniate of iron; Phillips. Fer arséniaté; Hauy. Hexadrischer Lirokon-Malachit; Mohs. Pharmakosiderit; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *p* 122. The forms *o*, *p* are hemihedral with inclined faces.

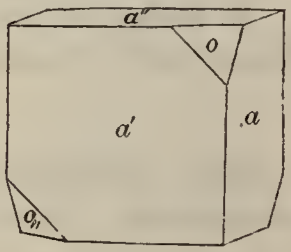
aa′	90°	0′	*pp′*	27°	16′
oo,	109	28	*pa*	70	32
oa	54	44	*pa′*	48	11
dd′	60	0	*po*	15	48
da′	45	0	*pd*	19	28
do	35	16			

FIG. 497.



Form and combinations. *a*, *ao′*, *ap′..o′.d.p`*. The faces *a* sometimes striated parallel to their intersections with the faces of *o′*, or curved; *o*, *p* frequently curved. Cleavage. *a*, difficult to obtain, and imperfect. Fracture uneven...conchoidal. Semi-transparent ...translucent on the edges. Lustre vitreous, inclining to adamantine. Green of various shades, yellowish-brown, blackish-brown. Streak light straw-yellow. H = 2·5. G = 2·9...3·0. Pyroelectric.

FIG. 498.



In the matrass yields water and becomes red. Before the blowpipe on charcoal emits fumes of arsenic and melts into a magnetic bead, which imparts the colour of iron to glass of borax. Soluble in hydrochloric acid. Is decomposed by potash, leaving a residue of red oxide of iron.

$\overset{\cdots}{\bar{\mathrm{F}}\mathrm{e}}{}^3\overset{\cdots\cdot\cdot}{\mathrm{As}}{}^2 + 12\dot{\mathrm{H}}$, arsenic acid 39·78, red oxide of iron 41·53, water 18·69.

Analysis by Berzelius :—

Arsenic acid	40·20
Phosphoric acid	2·53
Red oxide of iron	37·82
Oxide of copper	0·65
Water	18·61
Earthy matter	1·76

It is found in small attached crystals, and granular masses, in the veins of copper ores in the mines of Huel Gorland, Huel Unity and Carharack in Cornwall, St. Leonard near Limoges in France, Horhausen in Nassau, Langeborn in Spessart, Lobenstein in Reuss, Graul near Schwarzenberg in Saxony, in many parts of the United States.

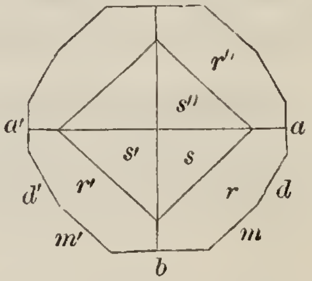
328. SCORODITE.—Martial Arseniate of copper ; Phillips. Scorodite ; Beudant. Peritomes Fluss-Haloid ; Mohs. Skorodit ; Hausmann, Haidinger.

Prismatic. 011,010=42° 20′ ; 101,001=43° 38′·5 ; 110,100=49° 1′.

a 100, *b* 010, *c* 001, *n* 021, *m* 110, *d* 210, *r* 111, *s* 112. *n* truncates the edge *bc*.

bc	90°	0′	*rr′*	65°	26′
ca	90	0	*rr″*	76	55
ab	90	0	*r′r″*	110	58
nb	24	30	*rm*	34	31
ma	49	1	*ss′*	45	22
mb	40	59	*ss″*	52	42
mm′	81	58	*s′s″*	72	2
dd	120	10	*sm*	53	59

FIG. 499.



Combinations. *cr*, *crnda*, *crndab*, *rndab*. Cleavage. *d*, imperfect ; *a*, *b*, traces. Fracture uneven. Semi-transparent… translucent on the edges. Lustre vitreous, inclining to adamantine on the faces ; surface of fracture inclining to resinous. Green and blue of various shades, liver-brown. Dichromatic. Streak white. Rather brittle. H = 3·5…4·0. G = 3·18…3·30.

In the matrass yields water and becomes yellow. Before the blowpipe on charcoal emits fumes of arsenic, and melts into a bright, grey, magnetic slag. Soluble in hydrochloric acid. The solution is brown, and yields no precipitate with chloride of gold. Is decomposed by potash, leaving a residue of red oxide of iron.

$\overset{\cdots}{\bar{\text{F}}\text{e}}\overset{\cdots\cdot\cdot}{\text{As}} + 4\dot{\text{H}}$, arsenic acid 49·78, red oxide of iron 34·64, water 15·58.

Analyses of scorodite *a* from the Brazils by Berzelius, *b* from Vaulry, G = 3·11, *c* from Cornwall, *d* from Schwarzenberg, *e* from the Brazils, G = 3·18, all by Damour, *f*, amorphous, from Marmato in New Granada by Boussingault, *g*, amorphous, from Nertschinsk by Hermann:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Arsen. acid . .	50·78	50·95	51·06	52·16	50·96	49·6	48·05
Phosph. acid .	0·67	—	—	oxide of lead		0·4	—
Red ox. iron .	34·85	31·89	32·74	33·00	33·20	34·3	36·41
Water	15·55	15·64	15·68	15·58	15·70	16·9	15·54

In small attached crystals; botryoidal and reniform masses; compact. It is probably a product of the decomposition of lölingite and mispickel, with which it is frequently associated.

Is found at Schwarzenberg and Schneeberg in Saxony, in the tin mines of Schlackenwald and Schönfeld in Bohemia, Horhausen in Siegen, Löling near Hüttenberg in Carinthia, Vaulry near Limoges in France; St. Austle in Cornwall in veins of tin ore, Antonio Pereira near Villa Rica in the Brazils, Loaysa near Marmato in Columbia, near Nertschinsk in Siberia.

329. VIVIANITE.—Phosphate of iron; Phillips. Ferphosphaté; Hauy. Dichromatisches Euklas-Haloid; Mohs. Eisenblau; Hausmann. Vivianit; Haidinger.

Oblique. 101,100 = 54° 13′; 111,010 = 59° 35′; 101,001 = 54° 22′.

a 100, *b* 010, *c* 001, *e* 011, *w* 101, *o* 103 cleavage, *n* $\bar{1}01$, *t* 201, *m* 110, *y* 310, *v* 111, *r* 112, *x* $\bar{1}11$, *z* $\bar{1}12$.

cb	90°	0′	*eb*	55°	33′	*vb*	59°	35′
ab	90	0	*ec*	34	27	*vw*	30	25
ca	108	35	*ma*	34	24	*rb*	70	26
wa	54	13	*mb*	55	36	*zb*	74	41
wc	54	22	*mm′*	111	12	*xb*	67	7
oa	89	5	*ya*	12	53	*xn*	22	53
na′	35	40	*yb*	77	7	*rba*	79	7
na	144	20	*yy′*	154	14	*zba*	130	52

FIG. 500.

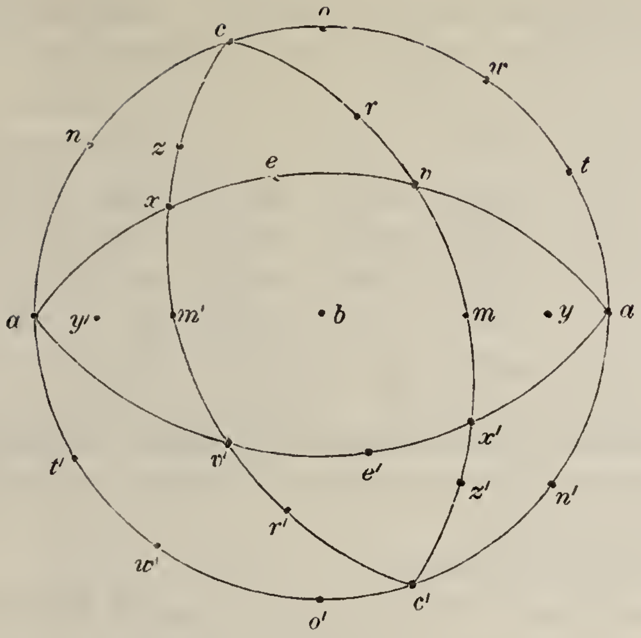
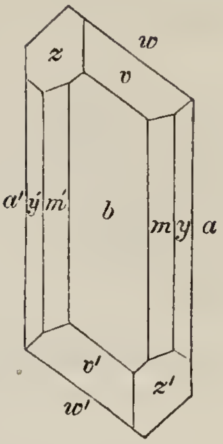


FIG. 501.



Combinations. *abw*, *abcme*, *abwm..v.y*, *abwymvz*, *abwmxzvr.n.* The faces *a*, *y*, *m* striated parallel to their intersections with *b*. Cleavage. *b*, very perfect; traces parallel to *a* and *o*. Fracture not observable. Transparent...translucent. Least transparent in a direction perpendicular to *b*. Lustre, *b* pearly, almost metallic, the other faces vitreous. Pale blackish-green...indigo-blue. Pleochromatic. Streak blueish-white, changing soon into indigo-blue. The powder rubbed in a dry state liver-brown. Sectile. In thin plates flexible. H = 1·5...2·0. G = 2·6...2·7.

In the matrass intumesces and becomes covered with grey and red spots. Before the blowpipe on charcoal becomes red, and then melts into a bright grey magnetic bead. Imparts the colour of iron to the fluxes. Soluble in hydrochloric acid and in nitric acid.

$\dot{\mathrm{Fe}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}} + 8\dot{\mathrm{H}}$, phosphoric acid 28·38, protoxide of iron 42·97, water 28·65.

Analyses of crystallized vivianite *a* from St. Agnes in Cornwall by Stromeyer, *b* from Bodenmais by Vogel, *c* from the Isle of France by Dufrénoy, *d*, *e* from Mullica Hills in New Jersey, *f* from Bodenmais, all by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*
Phosphoric acid . .	31·18	26·4	26·90	28·40	not det.	29·01
Protox. iron . . .	41·23	41·0	42·10	33·91	33·98	35·65
Red ox. iron . . .	—	—	—	12·06	12·06	11·60
Water	27·48	31·0	28·50	not det.	27·49	not det.

Analyses of vivianite from Mullica Hills in New Jersey *g* by Thomson, *h* by Vanuxem, of earthy vivianite *i* from Hillentrup in Lippe by Brandes, *k* from Alleyras by Berthier, *l* from Kertsch in the Crimea by Segeth, *m*, in colourless transparent crystals, from Cantwell's Bridge in the United States by W. Fisher :—

	g	*h*	*i*	*k*	*l*	*m*
Phosph. acid . . .	26·06	25·85	30·33	23·1	24·95	27·17
Protox. iron . . .	46·31	44·54	43·79	43·0	48·79	44·10
Alumina	—	0·40	0·70	0·6	—	—
Ox. mangan. . . .	—	—	—	0·3	S̈i	0·10
Water	27·14	28·26	25·00	32·4	26·26	27·17

By exposure to the atmosphere the colour of vivianite changes from white to blue, and part of the protoxide of iron contained in it is converted into the red oxide.

In attached crystals; fibrous; earthy.

Crystals of vivianite are found in the gold veins of Vöröspatak in Transylvania, in the veins of tinstone and copper ore of St. Agnes in Cornwall, with copper and iron pyrites at Bodenmais, and in brown iron ore at Amberg in Bavaria, Imleytown and Haarlem in New Jersey. The fibrous varieties are found in basaltic lava in the Isle of France, near Kertsch in the Crimea, Allentown and Mullica in New Jersey. The earthy varieties are commonly found in peat bogs.

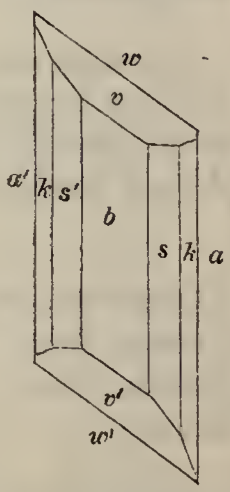
330. ERYTHRINE.—Cobalt bloom; Phillips. Cobalt arseniaté; Hauy. Diatomes Euklas-Haloid; Mohs. Kobalt blüthe; Hausmann. Erythrin; Haidinger.

Oblique. 101,100 = 55° 9′; 111,010 = 59° 11′·5; 101,001 = 53° 57′.

a 100, *b* 010, *o* 103, *w* 101, *q* $\bar{3}02$, *s* 340, *k* 320, *v* 111. *o*, *q* truncate the edge *wa′*.

ab	90°	0′	*sa*	42°	54′
wb	90	0	*ss′*	94	12
wa	55	9	*kb*	65	5
oa	89	52	*ka*	24	55
ow	34	43	*kk′*	130	10
qa	27	29	*vb*	59	12
qw	82	38	*vw*	30	48
sb	47	6	*vv′*	118	23

FIG. 502.



The faces *b*, *s*, *k*, *a* striated parallel to their intersections with each other. Combinations. *wab*, *wosb*, *wqsab*, *wvskab*. Cleavage. *b*, very perfect; *a*, *o* traces. Transparent...translucent. Least transparent in a direction perpendicular to *b*. Lustre on *b* pearly; the other faces adamantine, inclining to vitreous. Red of various shades, grey, green. The red varieties incline to blue when viewed in a direction perpendicular to *b*. Streak peach-blossom-red. Sectile. In thin plates flexible. H = 1·5...2·0. The lowest degree of hardness on *b*. G = 2·9...3·1.

In the matrass gives off water and turns blue, but yields no sublimate. The red varieties from Schneeberg become green. Before the blowpipe on charcoal emits arsenical vapours, and melts in the inner flame into a blackish-grey globule of arsenide of cobalt. Imparts a smalt blue colour to glass of borax. Soluble in hydrochloric acid, forming a rose-red solution. Becomes black when digested in potash.

$\dot{C}a^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{As} + 8\dot{H}$, oxide of cobalt 37·56, arsenious acid 38·39, water 24·05.

Analyses of erythrine from Schneeberg by Kersten:—

Arsenic acid	38·43	38·30	38·10
Oxide of cobalt	36·52	33·42	29·19
Protoxide of iron . . .	1·01	4·01	—
Lime	—	—	8·00
Water	24·10	24·08	23·90

In attached acicular crystals, elongated in the direction of the edge *a, b;* botryoidal; coating other minerals in the state of a red powder. Occurs usually in beds and veins with other ores of cobalt.

Is found at Schneeberg and Annaberg in Saxony, Joachimsthal in Bohemia, Saalfeld and Glücksbrunn in Thuringia, Riechelsdorf and Bieber in Hessia, Wolfach and Wittichen in Baden, Allemont in Dauphiné, St. Jean in the valley of Gistain in the Pyrenees, Modum in Norway.

331. ANNABERGITE.—Arseniate of nickel; Phillips. Nickel arseniaté; Hauy. Nickelblüthe; Hausmann. Nickelocher; Haidinger.

Oblique. Apparently isomorphous with erythrine and vivianite.

b 010.

Cleavage. *b*, very perfect. Green of various shades. Streak greenish-white. H = 2·5...3·0. G = 3·078...3·131.

In the matrass yields water. Before the blowpipe on charcoal emits fumes of arsenic, and melts into a bead of arsenide of nickel. Soluble in nitric acid.

$\dot{\mathrm{Ni}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}} + 8\dot{\mathrm{H}}$, arsenic acid 38·37, oxide of nickel 37·59, water 24·04.

Analyses of annabergite *a* from Riechelsdorf by Stromeyer, *b* from Allemont by Berthier, *c*, *d*, *e* from Schneeberg by Kersten:—

	a	*b*	*c*	*d*	*e*
Arsenic acid	36·97	36·8	38·30	38·90	37·21
Sulphuric acid	0·23	arsenious acid			0·52
Oxide of nickel	37·35	36·2	36·20	35·00	36·10
Oxide of cobalt	—	2·5	1·53	—	—
Protoxide of iron	1·13	—	—	2·21	1·10
Water	24·32	25·5	23·91	24·02	23·92

In capillary crystals; compact; earthy. It is a product of the decomposition of various ores containing nickel and arsenic.

Is found at Andreasberg in the Harz, Riechelsdorf and Bieber in Hessia, Glücksbrum and Saalfeld in Thuringia, Annaberg, Schneeberg and some other places in Saxony, Joachimsthal in Bohemia, Allemont in Dauphiné, Texas.

332. KÖTTIGITE.—Köttigite; Dana.

Oblique. Apparently isomorphous with erythrine and vivianite.

Cleavage. *b*, very perfect. Translucent. Lustre of surface of fracture silky. Light carmine-red...peach-blossom-red. Streak reddish-white. H = 2·5...3·0. G = 3·1.

In the matrass yields water and assumes a pale smalt blue colour. Before the blowpipe on charcoal in the outer flame fuses, emits fumes of arsenic, and leaves a slag of oxide of zinc. Yields the reactions of cobalt and nickel. Is soluble in acids.

$\dot{\mathrm{Zn}}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}} + 8\dot{\mathrm{H}}$, part of the oxide of zinc being replaced by oxides of cobalt and nickel.

Analysis by Kötting:—

Arsenic acid (loss)	37·17
Oxide of zinc	30·52
Oxide of cobalt	6·91
Oxide of nickel	2·00
Lime	trace
Water	23·40

Is found in fibrous crystalline crusts and massive, with smaltine in the Daniel mine near Schneeberg.

333. SYMPLESITE.—Symplesit; Mohs, Hausmann, Haidinger.

Oblique.

b 010.

Cleavage. *b*, perfect. Fracture even. Transparent...translucent. Lustre vitreous, on the faces of cleavage pearly. Pale indigo-blue...celadon-green. Streak blueish-white. Tolerably sectile. H = 2·5. G = 2·957.

In the matrass becomes brown and yields 25 per cent. of water. Infusible before the blowpipe; on charcoal emits a strong arsenical smell, becoming black and magnetic. With fluxes exhibits the reaction of iron and traces of manganese.

According to Plattner, contains arseniate of protoxide of iron, water, and a little sulphuric acid and manganese.

Is found in very delicate crystals resembling erythrine, and in small nodular masses at Klein Friesa near Lobenstein.

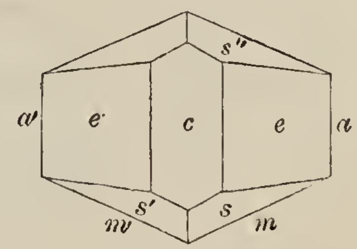
334. ROSELITE.—Roselite; Beudant. Roselit; Mohs, Hausmann, Haidinger.

Prismatic. 011,010 = 35° 7′; 101,001 = 31° 51′; 110,100 = 66° 24′.

c 001, *a* 100, *e* 203, *m* 110, *s* 111.

ac	90°	0′		*sa*	70°	21
ec	22	30		*sc*	57	12
ea	67	30		*sm*	32	48
ee′	45	0		*ss″*	100	45
ma	66	24		*ss′*	39	18
mm	47	12		*s′s″*	114	24

FIG. 503.



Combination. *acmes*. Cleavage. *a*, perfect. Fracture conchoidal. Translucent. Lustre vitreous. Deep rose-red. Streak white. H = 3·0.

In the matrass yields water, and becomes black. Before the blowpipe in the outer flame imparts a deep blue colour to borax. Is soluble in hydrochloric acid.

Contains arsenic acid, lime, magnesia, oxide of cobalt, and water.

Is found in small attached crystals at Schneeberg.

According to Haidinger, the crystals are twins of the oblique system, *a* being the twin-face.

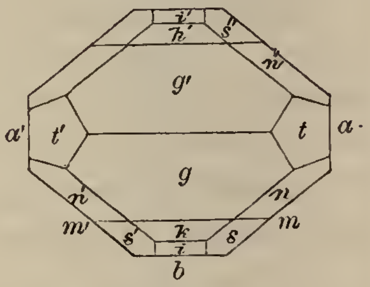
335. HAIDINGERITE.—Haidingerite; Dufrénoy. Prismatisches Euklas-Haloid; Mohs. Haidingerit; Hausmann, Haidinger.

Prismatic. 011,010 = 59° 16′; 101,001 = 26° 31′; 110,100 = 50° 0′.

a 100, *b* 010, *g* 012, *k* 021, *i* 041; *t* 101, *m* 110, *s* 241, *n* 452.

ii′	134°	23′	*mm′*	80°	0′
kk′	99	52	*ss′*	42	19
gg′	33	7	*ss″*	118	33
ta	63	29	*s′s″*	137	35
tt′	53	2	*nn′*	53	14
ma	50	0	*nn″*	120	28
ba	90	0	*n′n″*	121	37

FIG. 504.



Combinations. *gtkmab*, *gtknismab*. The faces *g*, *k*, *i* rough; *s*, *n* rounded. Cleavage. *a*, very perfect and easily obtained. Transparent...semi-transparent. Lustre vitreous. White. Streak white. Sectile. In thin plates flexible. H = 2·0...2·5. G = 2·848

In the matrass yields water. Melts before the blowpipe into a white enamel. Upon charcoal in the inner flame emits a smell of arsenic. Soluble in nitric acid.

$\dot{\mathrm{C}}\mathrm{a}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}} + 4\dot{\mathrm{H}}$, arsenic acid 55·54, lime 27·06, water 17·40.

Analysis by Turner :—

Arseniate of lime . . .	85·68
Water	14·32

In attached crystals elongated in the direction of the edge *ab*, and crystalline crusts, associated with pharmacolite.

This very rare mineral is supposed to have been found at Joachimsthal in Bohemia.

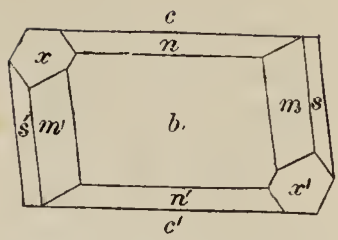
336. PHARMACOLITE.—Pharmacolite; Phillips. Chaux arseniaté; Hauy. Hemiprismatisches Euklas-Haloid; Mohs. Pharmakolith; Hausmann, Haidinger.

Oblique. 101,100 = 54° 58′; 111,010 = 73° 50′; 101,001 = 28° 16′.

b 010, *c* 001, *n* 011, *m* 110, *s* 310, *x* $\bar{3}21$.

cb	90° 0′	*sb*	78° 33′
nb	70 34	*xb*	69 38
nn′	141 8	*mc*	84 13
mb	58 42	*mbc*	83 14
mm′	117 24	*xbc*	65 17

FIG. 505.



Combinations. *cnmb*, *xcnmsb*. The faces *m*, *s* striated parallel to their intersection with each other; *c*, *n* striated parallel to their intersections with each other. Cleavage. *b*, very perfect and easily obtained. Transparent...translucent. Lustre vitreous; *b*, pearly. White, inclining to yellow. Streak white. Sectile. Flexible in thin plates. H = 2·0...2·5. G = 2·64...2·73.

In the matrass yields water. In the outer flame melts into a white enamel. On charcoal in the inner flame emits fumes of arsenic, and melts into a semi-transparent globule. Soluble without effervescence in nitric acid.

$\dot{C}a^2\overset{.....}{As} + 6\dot{H}$, arsenic acid 51·09, lime 24·90, water 24·01.

Analyses of pharmacolite *a* from Wittichen by Klaproth, from Andreasberg *b* by John, *c* by Turner, *d* from Riechelsdorf by Stromeyer, *e* from Glücksbrunn by Rammelsberg:—

	a	*b*	*c*	*d*	*e*
Arsenic acid	50·54	45·68	79·01	46·97	51·58
Lime	25·00	27·28		24·65	23·59
Magnesia	—	—	—	3·22	—
Oxide of cobalt . . .	—	—	—	1·00	1·43
Water	24·46	23·86	20·99	23·98	23·40

Is found in minute fibrous crystals, botryoidal masses, and earthy, at Joachimsthal in Bohemia, Wittichen in Baden, Andreasberg in the Harz, Riechelsdorf and Bieber in Hessia, Glücksbrunn in Thuringia, Markirchen in Alsace.

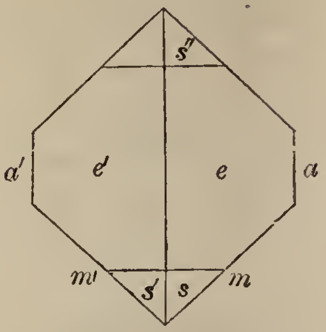
337. LIBETHENITE.—Phosphate of copper; Phillips. Cuivre phosphaté; Dufrénoy. Diprismatischer Oliven-Malachit; Mohs. Libethenit; Hausmann, Haidinger.

Prismatic. 011,010 = 53° 50′; 101,001 = 35° 4′; 110,100 = 46° 10′.

a 100, *b* 010 cleavage, *e* 101, *m* 110, *t* 120, *s* 111. *b* truncates the edge *mm′*; *t* truncates the edge *bm*.

ab	90°	0′	*se*	30°	54′
ea	54	56	*ss″*	61	48
ee′	70	8	*sm*	44	37
ma	46	10	*s′s″*	90	46
mm′	87	40	*ta*	64	22
ss′	59	4	*tt′*	51	16

FIG. 506.



Combinations. *em*, *ems*, *emas*. Cleavage. *a*, *b*, very imperfect. Fracture conchoidal...uneven. Translucent...translucent on the edges. Lustre resinous. Olive-green, usually dark. Streak olive-green. Brittle. H = 4·0. G = 3·6...3·8.

Decrepitates when heated suddenly. Melts before the blowpipe into a black bead containing a globule of copper. On charcoal is easily reduced to metallic copper. With lead yields copper and phosphate of oxide of lead. Soluble in nitric acid and in ammonia.

$\dot{\mathrm{C}}\mathrm{u}^3\overset{.....}{\mathrm{P}} + \dot{\mathrm{C}}\mathrm{u}\dot{\mathrm{H}}$, phosphoric acid 29·84, oxide of copper 66·40, water 3·76.

Analyses of libethenite *a* from Libethen by Berthier, *b* by Kühn, *c* from Nischne-Tagilsk by Hermann, *d* from Ehl, G = 4·27, by Rhodius :—

	a	*b*	*c*	*d*
Phosphoric acid	28·7	29·44	28·61	28·9
Oxide of copper	63·9	66·94	65·89	63·1
Water	7·4	4·05	5·50	7·3

According to Berzelius, part of the phosphoric acid is replaced by arsenic acid.

In crystals; globular, reniform and compact masses.

Is found in cavities in mica slate at Libethen in Hungary, Ehl near Linz on the Rhine, at Gunnis Lake in Cornwall, with malachite at Nischne-Tagilsk in the Ural.

Libethenite and olivenite are isomorphous. The formula for libethenite differs from that of olivenite only in the substitution of $\overset{.....}{\mathrm{P}}$ for $\overset{.....}{\mathrm{As}}$.

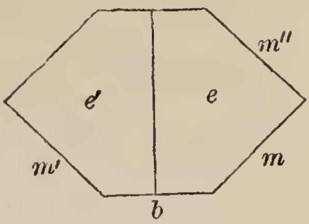
338. OLIVENITE.—Right prismatic arseniate of copper; Phillips. Olivénite; Beudant. Prismatischer Oliven-Malachit; Mohs. Pharmacochalcit; Hausmann. Olivenit; Haidinger.

Prismatic. 011,010=54° 14′; 101,001=34° 35′; 110,100=46° 15′.

a 100, *b* 010, *v* 011, *e* 101, *m* 110. *a* truncates the edge *mm″*; *v* truncates the angle *bee′*.

ab	90°	0′	*ee′*	69°	10′
vb	54	14	*ma*	46	15
vv′	71	32	*mb*	43	45
va	90	0	*mm′*	87	30
ea	55	25			

FIG. 507.



Combinations. *em*, *emb*, *ema*, *emba*. The faces *e*, *a* generally concave; *m*, convex and uneven. Cleavage. *e*, *m*, traces. Fracture conchoidal, uneven. Semi-transparent...opaque. Lustre vitreous, inclining to adamantine or resinous. Olive-green passing into blackish-green and brown. Streak olive-green. Brittle. H = 3·0. G = 4·1...4·38.

In the matrass yields water. In the forceps melts easily before the blowpipe into a globule studded with prismatic crystals. On charcoal emits fumes of arsenic and melts into a brittle globule of arsenide of copper. Soluble in nitric acid and in ammonia. Is decomposed by potash, leaving a residue of oxide of copper.

$\dot{Cu}^3 \overset{.....}{As} + \dot{Cu}\dot{H}$, arsenic acid 40·66, oxide of copper 56·16, water 3·18. Part of the arsenic acid is sometimes replaced by phosphoric acid.

Analyses of olivenite from Cornwall *a* by v. Kobell, *b*, *c* by Richardson, *d*, G = 4·135, *e*, G = 3·913, both by Hermann, *f* by Thomson, *g*, G = 4·378, by Damour:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Arsen. ac. . .	36·71	39·9	39·80	33·50	40·50	40·61	34·87
Phosph. ac. . .	3·36	—	—	5·96	1·00	—	3·43
Ox. copper . .	56·43	56·2	56·65	56·38	51·03	54·98	56·86
Protox. iron .	—	—	—	—	3·64	—	—
Water	3·50	3·9	3·55	4·16	3·83	4·41	3·72

In attached crystals, frequently acicular and capillary; in fibrous, botryoidal and reniform masses having a drusy surface and a fibrous fracture; earthy. It is probably produced by the decomposition of fahlerz containing arsenic, which is sometimes found in the interior of the massive and earthy varieties of olivenite.

Is found in Cornwall in the veins of copper ore in the mines of Huel Gorland and Huel Unity near St. Day, and Tin Croft near Redruth, at Tyne head mine near Alston Moor in Cumberland. The massive and earthy varieties are found at Kamsdorf and Saalfeld in the Thüringer Wald, Schwatz and Kogel in the Tyrol, the Banat, Siberia, the Asturias, Chile.

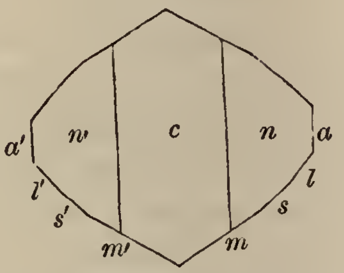
339. EUCHROITE.—Euchroite; Dufrénoy. Prismatischer Smaragd-Malachit; Mohs. Euchroit; Hausmann, Haidinger.

Prismatic. 011,010 = 30° 24′; 101,001 = 46° 4′; 110,100 = 58° 40′.

a 100, *c* 001, *n* 101, *m* 110, *s* 320, *l* 210.

ac	90° 0′		*ma*	58° 40′
mc	90 0		*mm′*	62 40
nc	46 4		*sa*	47 36
na	43 56		*ss′*	84 48
nn′	92 8		*ll′*	101 13

FIG. 508.



Combinations. *cnml*, *cnmsla*. The faces *m*, *s*, *l* striated parallel to their intersections with each other; *c*, frequently convex. Cleavage. *n*, *m*, traces. Fracture uneven...conchoidal. Transparent...translucent. Lustre vitreous. Emerald-green. Streak apple-green. Rather brittle. H = 3·5...4·0. G = 3·35...3·45.

In the matrass yields water, assumes a yellowish-green colour, and becomes friable. Ignited with charcoal powder in the matrass yields a sublimate of arsenic and arsenious acid. When heated to a certain point before the blowpipe on charcoal it emits an arsenical smell, and is reduced in an instant with a kind of detonation. Soluble in nitric acid.

$\dot{\mathrm{C}}\mathrm{u}^4 \overset{.....}{\mathrm{As}} + 7\dot{\mathrm{H}}$, arsenic acid 34·14, oxide of copper 47·15, water 18·71.

Analyses *a* by Turner, *b*, *c* by Kühn, *d* by Wöhler:—

	a	*b*	*c*	*d*
Arsenic acid	33·02	34·42	32·42	33·22
Oxide of copper . . .	47·85	46·97	46·99	48·09
Lime	—	—	1·12	—
Water	18·80	19·31	19·31	18·39

Is found in attached crystals, in mica slate, at Libethen near Neusohl in Hungary.

340. ERINITE.—Monotomer Dystom-Malachit; Mohs. Erinit; Hausmann, Haidinger.

Traces of cleavage in one direction. Fracture imperfect conchoidal...uneven. Translucent on the edges. Lustre slightly resinous, dull. Emerald-green, inclining to grass-green. Streak the same, approaching to apple-green. Brittle. H = 4·5...5·0 G = 4·043.

Before the blowpipe emits fumes of arsenic and melts. Soluble in nitric acid.

$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}} + 2\dot{\mathrm{H}}$, arsenic acid 34·68, oxide of copper 59·89, water 5·43.

Analysis by Turner:—

Arsenic acid	33·78
Oxide of copper	59·44
Alumina	1·77
Water	5·01

In mammillary and reniform masses, having a drusy surface, and consisting of concentric layers.

Is said to have been found in the county of Limerick.

341. CORNWALLITE.—Cornwallit; Zippe.

Amorphous. Fracture conchoidal, passing into verdigris-green and blackish-green. H = 4·5. G = 4·166.

In the matrass yields water. Before the blowpipe on charcoal emits fumes of arsenic, and yields a bead of copper surrounded by a brittle crust.

$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}} + 5\dot{\mathrm{H}}$, arsenic acid 32·07, oxide of copper 55·37, water 12·56. Part of the arsenic acid is replaced by phosphoric acid.

Analyses by Lerch:—

Arsenic acid	29·78	30·65
Phosphoric acid	2·54	1·77
Oxide of copper	55·00	54·22
Water	12·68	13·36

Is found in botryoidal, reniform and compact masses, with olivenite in Cornwall.

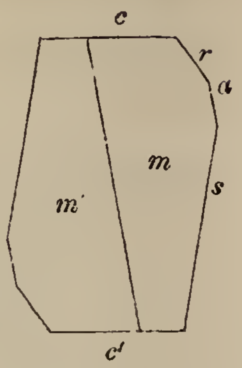
342. KLINOCLASE.—Oblique prismatic arseniate of copper; Phillips. Aphanése; Beudant. Diatomer Habronem-Malachit; Mohs. Klinoklas; Hausmann. Abichit; Haidinger.

Oblique. 101,100 = 24° 18′; 111,010 = 32° 15′; 101,001 = 56° 12′.

a 100, *c* 001, *s* 30$\bar{2}$, *r* 101, *m* 110.

ac	80° 30′	*sc*	99° 30′
ra	24 18	*ma*	62 0
rc	56 12	*mm′*	56 0
sa	19 0		

FIG. 509.



Combinations. *cm*, *cmrs*, *cmrsa*. Cleavage. *c*, very perfect. Fracture uneven. Translucent...opaque. Lustre vitreous, inclining to resinous; on *c* inclining to pearly. Blackish-green or black externally; in the interior verdigris-green...sky-blue. Streak blueish-green. Rather brittle. H = 2·5...3·0. G = 4·19...4·36.

Before the blowpipe intumesces, emits arsenical vapours, and melts easily. On continuing the blast, it ignites suddenly and yields a globule of copper. Is soluble in acids and in ammonia.

$\dot{Cu}^3\overset{.....}{As} + 3\dot{Cu}\dot{H}$, arsenic acid 30·24, oxide of copper 62·65, water 7·11.

Analyses *a* by Rammelsberg, *b* by Damour:—

	a	*b*
Arsenic acid	29·71	27·08
Phosphoric acid	0·64	1·50
Oxide of copper	60·00	62·80
Oxide of iron	0·39	0·49
Lime	0·50	—
Water	7·64	7·57
Silica	1·12	—

In crystals and hemispherical and reniform masses, having a columnar structure and drusy surface.

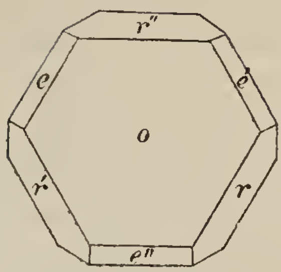
Is found with liroconite in the veins of Huel Muttrell, Huel Gorland and Huel Unity in Cornwall, Altväter and Esching in Mordelgrund near Saida in the Erzgebirge.

343. TAMARITE.—Rhomboidal arseniate of copper; Phillips. Cuivre arseniaté hexagonal lamelliforme; Hauy. Rhomboedrischer Euchlor-Malachit; Mohs. Chalkophyllit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 71° 16′.

o 111, *b* $2\bar{1}\bar{1}$, *r* 100, *e* 011, *v* 411. *v* truncates the edge *ro*.

FIG. 510.



bo	90° 0′	vo	55° 51′
bb''	60 0	rr'	110 12
ro	71 16	ee'	91 14
eo	55 51		

Combinations. *or*, *orb*, *ore*, *orev*. Cleavage. *o*, very perfect; *r*, traces. Fracture conchoidal, hardly observable. Transparent… translucent. Lustre, *o*, pearly; *r*, vitreous, inclining to adamantine. Emerald-green, grass-green, verdigris-green. Streak the same, lighter. Sectile. H = 2·0. G = 2·435…2·659.

In the matrass decrepitates violently, becomes black and yields much water. Before the blowpipe on charcoal emits fumes of arsenic and melts into a grey metallic globule, which with soda affords metallic copper. Is soluble in acids and in ammonia.

Analyses *a* by Hermann, *b*, *c* by Damour:—

	a	*b*	*c*
Arsenic acid	17·51	19·35	21·27
Phosphoric acid	3·93	1·29	1·56
Alumina		1·80	2·13
Oxide of copper	44·45	52·92	52·30
Protoxide of iron	2·92	—	—
Water	31·19	23·94	22·58

In crystals very thin in a direction perpendicular to *o*, massive and disseminated.

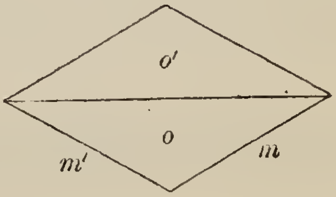
Is found with other ores of copper in veins in several mines near Redruth in Cornwall. It is said to have been found also at Altväter and Esching in the Mordelgrund near Saida in the Erzgebirge, and at Moldawa in the Banat.

344. LIROCONITE. — Octahedral arseniate of copper; Phillips. Cuivre arseniaté octaèdre obtus; Hauy. Prismatischer Lirokon-Malachit; Mohs. Chalkophacit; Hausmann. Lirokonit; Haidinger.

Prismatic. 011,010=36° 11′; 101,001=38° 20′; 110,100=59° 40′.

FIG. 511.

oo'	107° 38′
mm'	60 40



Combination. *om*. *o*, *m* faintly striated parallel to their intersections with each other. Cleavage. *o*, *m*, imperfect; *o* more distinct than *m*. Fracture imperfect conchoidal. Transparent...translucent. Lustre vitreous, inclining to resinous. Sky-blue...verdigris-green. Streak the same, but paler. Almost sectile. H = 2·0...2·5. G = 2·83...2·99.

In the matrass yields water, and becomes green, but does not decrepitate. Before the blowpipe on charcoal emits the smell of arsenic and melts into a brittle slag containing white metallic grains. With soda yields a bead of arsenide of copper. Is soluble in hydrochloric acid, nitric acid, and in ammonia.

Analyses *a* by Count Trolle-Wachtmeister, *b* by Hermann, *c*, *d* by Damour:—

	a	*b*	*c*	*d*
Arsenic acid	22·29	23·05	22·22	22·40
Phosphoric acid . . .	3·87	3·73	3·49	3·24
Oxide of copper . .	37·73	36·38	37·18	37·40
Alumina	8·61	10·85	9·68	10·09
Red oxide of iron . .	3·66	0·98	—	—
Water	23·84	25·01	25·49	25·44

Is found in attached crystals, rarely massive, in veins in the mines of Huel Muttrell, Huel Gorland and Huel Unity in Cornwall. In very small crystals at Herrngrund in Hungary, and Ullersreuth in Voigtland.

345. TYROLITE.—Kupferschaum; Phillips, Dufrénoy. Prismatischer Euchlor-Malachit; Mohs. Kuperschaum; Hausmann. Tirolit; Haidinger.

Prismatic.

a 100, *c* 001, *m* 110.

Combinations. *cm*, *cam*. The faces *m* striated parallel to their intersections with *c*. Cleavage. *c*, perfect. Translucent ...translucent on the edges. Lustre, on *c* pearly; on the other faces vitreous. Apple-green, verdigris-green, inclining to sky-blue. Streak the same. Very sectile. In thin leaves flexible. H = 1·0...2·0· G = 3·020...3·098.

In the matrass yields water. Decrepitates violently when heated. Before the blowpipe, in the forceps, it becomes black, and melts into a grey globule. On charcoal melts, emitting arsenical fumes. Soluble with effervescence in hot nitric acid. Is decomposed by ammonia, leaving a residue of carbonate of lime.

$\dot{\mathrm{C}}\mathrm{u}^{5}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}} + \dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}} + 10\dot{\mathrm{H}}$, arsenic acid 25·35, oxide of copper 43·77, water 19·85, carbonate of lime 11·03.

Analysis of tyrolite from Falkenstein by v. Kobell :—

Arsenic acid	25·01
Oxide of copper	43·88
Water	17·46
Carbonate of lime	13·65

In attached crystals, reniform and botryoidal masses, having a drusy surface and columnar structure.

Is found with other ores of copper, at Falkenstein near Schwatz, and other places in the Tyrol, Libethen in Hungary, the copper mines in the Banat, and near Saalfeld in Thuringia.

From a comparison of several specimens of tirolite and orichalchite, it appears that the colour, which is blueish-green in tirolite and yellowish-green in orichalchite, is a character by which the two minerals may be distinguished.

346. KONICHALCITE.—Konichalcite; Breithaupt.

Fracture splintery...granular. Translucent on the edges. Lustre vitreous, feeble. Intermediate between pistachio and emerald-green. Streak the same. Brittle. H = 4·25...4·75. G = 4·123.

$2\dot{\mathrm{R}}\overset{.....}{\mathrm{As}} + 3\dot{\mathrm{H}}$, where $\dot{\mathrm{R}}$ is $\dot{\mathrm{C}}\mathrm{u}$ and $\dot{\mathrm{C}}\mathrm{a}$, and part of the $\overset{.....}{\mathrm{As}}$ is replaced by $\overset{.....}{\bar{\mathrm{P}}}$.

Analysis by Fritzsche :—

Arsenic acid	31·55
Phosphoric acid	8·96
Vanadic acid	1·78
Oxide of copper	31·68
Lime	21·76
Water	5·49

In reniform masses, supposed to have been found at Hinojosa de Cordova in Andalusia.

347. EHLITE.—Ehlit; Hausmann, Haidinger.

Cleavable in one direction. Lustre on the cleavage faces pearly. Verdigris-green. Streak the same, paler. H = 1·5...2·0. G = 3·8.

Decrepitates when heated.

$\dot{\mathrm{C}}\mathrm{u}^5\overset{.....}{\mathrm{P}} + 3\dot{\mathrm{H}}$, phosphoric acid 24·1, oxide of copper 66·8, water 9·1.

Analyses of ehlite *a*, *b*, *c* from Ehl by Bergemann, *d* from Nischne-Tagilsk by Hermann :—

	a	*b*	*c*	*d*
Phosphoric acid . . .	24·93	—	—	23·14
Oxide of copper . .	65·99	65·74	64·85	66·86
Water	9·06	8·56	8·93	10·00

Is found in reniform and botryoidal masses, at Ehl on the Rhine, and at Nischne-Tagilsk in the Ural.

Kupferdiaspore, a fibrous mineral from Libethen, is supposed by Hermann to be the same as ehlite. When heated it falls to powder, and is dispersed, without decrepitating. According to Kühn, its formula is $\dot{Cu}^5\overset{\cdot\cdot\cdot\cdot\cdot}{P} + 2\dot{H}$. His analysis gave, phosphoric acid 24·13, oxide of copper 69·61, water 6·26.

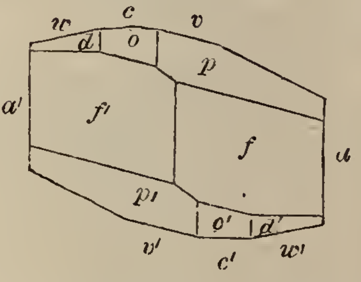
348. LUNNITE.—Hydrous phosphate of copper; Phillips. Cuivre hydrophosphaté; Dufrénoy. Hemiprismatischer Dystom-Malachit; Mohs. Pseudomalachit; Hausmann. Lunnit; Haidinger.

Oblique. 101,100 = 64° 28′; 111,010 = 58° 54′; 101,001 = 25° 32′.

a 100, *c* 001, *o* 011, *v* 102, *w* $\bar{1}02$, *f* 120, *p* 111, *d* $\bar{1}22$.

va	76°	34′	*ff′*	38°	56′
vc	13	26	*pa*	68	20
wc	13	26	*po*	21	40
wa′	76	34	*pp′*	117	49
oo′	112	37	*da′*	78	46
fa	70	32	*do*	11	14

FIG. 512.



Combinations. *cpof..va.w.d.* Cleavage. *a*, imperfect. Fracture small conchoidal...uneven. Semi-transparent...translucent on the edges. Lustre vitreous, inclining to adamantine. Green of various shades. Streak verdigris-green. Brittle. H = 4·5...5·0. G = 4·0...4·4.

Decrepitates when heated quickly. Before the blowpipe, when heated slowly, turns black and melts into a black bead containing a globule of copper. When melted with an equal volume of lead, the globule of copper is coated by a crystalline shell of phosphate of oxide of lead. Moistened with hydrochloric acid, it imparts a blue colour to the flame. Soluble in nitric acid and in ammonia.

$\dot{Cu}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P} + 3\dot{Cu}\dot{H}$, phosphoric acid 21·2, oxide of copper 70·8, water 8·0.

Analyses of lunnite from Rheinbreitenbach *a* by Arfvedson, *b* mean of three analyses by Kühn, *c* (G = 4·4) by Hermann, *d* (G = 4·2...4·4) by Rhodius :—

	a	*b*	*c*	*d*
Phosphoric acid	24·70	21·52	24·55	20·4
Oxide of copper	68·20	68·74	67·25	70·8
Water	5·97	8·64	8·20	8·4

Analyses of lunnite from Nischne-Tagilsk *g* fibrous (G = 4·25), *h* compact (G = 4·00), *i* crystalline (G = 4·4), all by Hermann, *k* from Hirschberg by Kühn :—

	g	*h*	*i*	*k*
Phosphoric acid	23·75	23·47	25·30	20·87
Oxide of copper	68·75	67·73	68·21	71·73
Water	7·50	8·80	6·49	7·40

In small crystals, fibrous, reniform, botryoidal and compact masses, disseminated.

Is found at Virneberg near Rheinbreitenbach on the Rhine, Siebenhitze not far from Hof in Bavaria, Hirschberg in Reuss, Nischne-Tagilsk in the Ural.

349. THROMBOLITE.—Thrombolite ; Dufrénoy. Thrombolith ; Hausmann, Haidinger.

Fracture conchoidal. Opaque...translucent on the edges. Lustre vitreous. Dark leek-green...emerald-green. Streak emerald-green. Brittle. H = 3·0...4·0. G = 3·381...3·401.

In the matrass yields water and blackens. Before the blowpipe on charcoal melts easily into a black globule, and is reduced. With borax and iron wire yields the reaction of phosphorus.

$\dot{C}u^3\overset{.....}{P}^2 + 6\dot{H}$, phosphoric acid 45·2, oxide of copper 37·7, water 17·1.

Analysis by Plattner :—

Phosphoric acid	41·0
Oxide of copper	39·2
Water	16·8

Occurs massive, with malachite, at Rezbanya in Hungary.

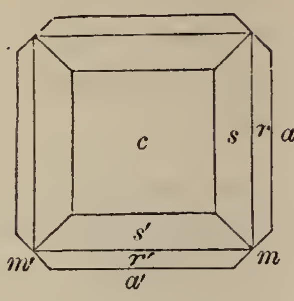
350. TORBERITE.—Uranite (in part) ; Phillips. Chalcolite ; Beudant. Pyramidaler Euchlor-Malachit ; Mohs. Chalkolith ; Hausmann, Haidinger.

Pyramidal. 101,001 = 51° 25′.

a 100, *c* 001, *m* 110, *r* 201, *e* 101, *s* 203, *x* 102.

ac	90°	0′	*sa*	50°	7′
aa′	90	0	*ea*	38	35
ma	45	0	*ra*	21	45
xc	32	4	*xx′*	44	6
sc	39	53	*ss′*	53	56
ec	51	25	*ee′*	67	7
rc	68	15	*rr′*	82	6
xa	57	56			

FIG. 513.



Combinations. *cr*, *cx*, *ce*, *cs*, *csa*, *crs*, *crsm*, *crsam*. Cleavage. *c*, very perfect. Fracture not observable. Transparent... translucent. Lustre, pearly on *c*, the other faces vitreous, inclining to adamantine. Emerald-green, grass-green, sometimes leek-green, apple-green, siskin-green. Streak green. Rather brittle. H = 2·0...2·5. G = 3·5...3·6.

In the matrass yields water. Before the blowpipe on charcoal with soda yields a globule of copper. With borax in the outer flame fuses into a green glass, which in the inner flame becomes opaque and of a reddish-brown colour. Moistened with hydrochloric acid imparts a blue colour to the flame. Soluble in nitric acid and in ammonia. The nitric solution is green. The solution in ammonia blue.

$\dot{\mathrm{C}}\mathrm{u}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}} + \overset{\cdot\cdot\cdot}{\text{Ʉ}}{}^{2}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}} + 8\dot{\mathrm{H}}$, phosphoric acid 15·2, oxide of uranium 61·1, oxide of copper 8·4, water 15·3.

Analyses of torberite from Cornwall *a* by R. Phillips, *b* by Berzelius, *c* from Gunnislake by Werther:—

	a	*b*	*c*
Phosphoric acid	16·0	15·57	14·34
Oxide of uranium	60·0	61·39	59·03
Oxide of copper	9·0	8·44	8·27
Water	14·5	15·05	15·39

Is found in attached crystals, massive, and investing other minerals, in veins in slate and in granite, at Johann-Georgenstadt, Eibenstock and Schneeberg in Saxony, Joachimsthal and Zinnwald in Bohemia, Bodenmais in Bavaria, Reinerzau in Wirtemberg; in Cornwall in the mines of Carharack, Tin Croft and Huel Buller near Redruth, Tolcarn near St. Day, Huel Gorland, Huel Unity, Huel Edward in St. Just, St. Agnes, Stenna Gwyn near St. Austle, Gunnislake near Callington; in several places in the United States.

Werther obtained crystalline grains having the form and composition of torberite by boiling $\dot{\mathrm{H}}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}} + \overset{\cdot\cdot\cdot}{\bar{\mathrm{U}}}{}^{2}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}} + 8\dot{\mathrm{H}}$ with a solution of basic acetate of copper.

351. AUTUNITE.—Uranite (in part); Phillips, Beudant. Pyramidaler Euchlor-Malachit; Mohs. Uranit; Hausmann, Haidinger.

Pyramidal.

The forms and angles are supposed to be the same as those of torberite.

Cleavage. *c*, very perfect. Fracture not observable. Transparent...translucent. Lustre, pearly on *c*, vitreous inclining to adamantine on the other faces. Lemon-yellow, sulphur-yellow, siskin-green. Streak sulphur-yellow. Sectile. H = 1·0...2·0. G = 3·0...3·2.

In the matrass yields water. Before the blowpipe on charcoal melts into a black globule. With borax in the outer flame forms a yellow glass, in the inner flame a green glass. The solution in nitric acid is yellow, in ammonia colourless.

$\dot{\mathrm{C}}\mathrm{a}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}} + \overset{\cdot\cdot\cdot}{\bar{\mathrm{U}}}{}^{2}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}} + 8\dot{\mathrm{H}}$, phosphoric acid 15·5, oxide of uranium 62·6, lime 6·2, water 15·7.

Analyses of autunite from Autun *a* by Berzelius, *b* by Laugier, *c* by Werther:—

	a	*b*	*c*
Phosphoric acid	15·20	14·5	14·00
Oxide of uranium	61·73	55·0	63·28
Lime	5·88	4·6	5·86
Magnesia and protox. mangan.	0·20	—	—
Silica and red ox. iron	—	3·0	—
Barytes	1·57	—	1·03
Oxide of tin	0·06	—	—
Water	15·48	21·0	14·30

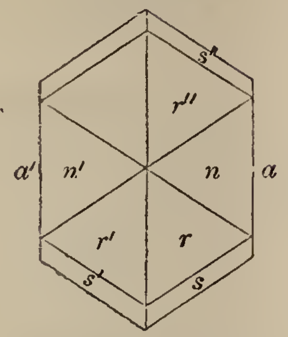
Is found in crystals, massive, and investing other minerals, in granite at St. Symphorien near Autun, and at St. Yrieux not far from Limoges in France.

352. CHILDRENITE. — Childrenite; Beudant, Mohs, Hausmann, Haidinger.

Prismatic. 011,010=46° 26′; 101,001=32° 44′; 110,100=55° 57′.

a 100, *n* 201, *s* 111, *r* 223.

FIG. 514.



na	37° 53′	*rr′*	39° 56′
nn′	104 14	*rr″*	60 28
sa	65 2	*r′r″*	74 50
ss′	49 56	*rs*	11 31
ss″	77 19	*sn*	42 34
s′s″	97 52	*rn*	40 52
ra	70 7		

Combinations. *nrs*, *nrsa*. Cleavage. *a*, imperfect. Fracture uneven. Transparent. Lustre vitreous, inclining to resinous. Yellowish-white, yellow, yellowish-brown. Streak white. H = 4·5...5·0.

Consists, according to Wollaston, of alumina, red oxide of iron, phosphoric acid, and water.

Is found in single attached crystals, and as a crystalline coating, on chalybite, pyrite, quartz, and sometimes with apatite, and in small distinct crystals on slate at Crinnis in Cornwall.

The angles given above were deduced from the measurements of some very good crystals in Mr. Brooke's collection.

353. KAKOXENE. — Kakoxene; Beudant. Kakoxen; Mohs, Hausmann, Haidinger.

Translucent...opaque. Lustre pearly, inclining to metallic. Yellow. Streak yellow. G = 2·336...3·38.

In the matrass yields water. Before the blowpipe becomes brown, and melts into a black magnetic slag. With borax forms an olive-green glass. Soluble in acids.

Analyses of kakoxene from Hrbek by Steinmann and Richardson:—

Phosphoric acid	17·86	20·5
Red oxide of iron	36·32	43·1
Alumina	10·01	—
Silica	8·90	2·1
Lime	0·15	1·1
Magnesia	—	0·9
Water and hydrofluoric acid . . .	25·95	30·2

In capillary crystals; globular and reniform masses; earthy.

Is found in the Hrbek mine near St. Benigna, and at Mauth in Bohemia. It is said to occur also at Amberg in Bavaria, and in several parts of the United States.

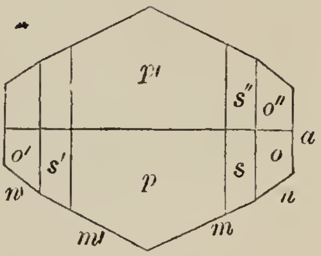
354. WAVELLITE.—Wavellite; Phillips, Dufrénoy. Prismatisches Wavellin-Haloid; Mohs. Wavellit; Hausmann, Haidinger.

Prismatic. 011,010=53° 23′; 101,001=20° 34′; 110,100=63° 12′·5.

a 100, *p* 011, *m* 110, *n* 430, *s* 111, *o* 211.

pa	90°	0′	*ss″*	69°	40′
pp′	73	14	*s′s″*	79	34
mm′	53	35	*sm*	50	13
na	56	3	*oo′*	62	7
nn′	67	54	*oo″*	61	27
sa	73	14	*o′o″*	93	7
ss′	33	32			

FIG. 515.



The faces *m* striated parallel to their intersections with *a*. Cleavage. *m*, *a*, tolerably perfect. Fracture imperfect conchoidal. Transparent...translucent. Lustre vitreous, on *m* and *a* inclining to pearly. Colourless, grey, green, yellow, brown, blue of various shades. Streak white. Brittle. H = 3·5...4·0. G = 2·3...2·4.

In the matrass yields water, which sometimes contains hydrofluoric acid, and corrodes the glass. Infusible before the blowpipe. With solution of cobalt becomes blue. Soluble in acids and in potash or soda. With sulphuric acid evolves hydrofluoric acid.

$\dddot{Al}^3\overset{.....}{P}^2 + 12\dot{H}$, phosphoric acid 35·3, alumina 38·0, water 26·7.

Analyses of wavellite *a* from Amberg, *b* from Barnstaple by Fuchs, *c* from Barnstaple by Berzelius, *d*, *e* from Freiberg by Erdmann, *f* from Beraun by Hermann :—

	a	*b*	*c*	*d*	*e*	*f*
Phosph. ac. . . .	34·72	35·12	33·40	34·06	33·28	34·29
Alumina	36·56	37·20	35·35	36·60	36·39	36·39
Red ox. iron . .	—	—	1·25	1·00	2·69	1·20
Lime	—	—	0·50	—	—	—
Hydrofl. ac. . . .	—	—	2·06	traces	traces	1·69
Water	28·00	28·00	26·80	27·40	27·10	26·34

In acicular radiating crystals, forming hemispheres, botryoidal and reniform masses, having a drusy surface.

Is found in crevices in slate near Barnstaple in Devonshire, in granite at Stennagwyn near St. Austle in Cornwall, near Newcastle, at Clonmel and near Cork in Ireland, in the Shaint islands on the coast of Scotland, Crehowitz, Ivina, Holubkau in Bohemia, Frankenberg and Langenstriegis in Saxony, near Giessen, Darmstadt, Amberg, Kauniok in Greenland, Villa Rica in the Brazils, Roxborough in Pennsylvania.

355. FISCHERITE.—Fischérite; Dufrénoy. Fischerit; Hausmann, Haidinger.

Transparent. Lustre vitreous. Light grass-green, passing into olive-green and verdigris-green. H = 5·0. G = 2·46.

When heated yields water and becomes opaque. With borax and salt of phosphorus forms glasses which show the colour of iron while they are hot, and that of copper after cooling. With solution of cobalt becomes blue. But slightly acted upon by hydrochloric and nitric acids. Completely soluble in sulphuric acid.

$\overset{\cdots}{\mathrm{Al}}{}^2\overset{\cdots\cdot\cdot}{\mathrm{P}} + 8\dot{\mathrm{H}}$, phosphoric acid 29·0, alumina 41·7, water 29·3.

Analysis by Hermann:—

Phosphoric acid	29·03
Alumina	38·47
Oxide of copper	0·80
Protoxides of iron and manganese	1·20
Phosphate of lime and gangue	3·00
Water	27·50

Is found in small six-sided prisms, and in crystalline crusts, near Nischne-Tagilsk in the Ural.

356. TURQUOISE.—Calaite; Phillips. Turquoise; Beudant. Untheilbarer Lasur-Spath; Mohs. Kallait; Hausmann. Türkis; Haidinger.

Amorphous. Not cleavable. Fracture conchoidal...uneven. Faintly translucent on the edges...opaque. Lustre vitreous, feeble. Azure-blue...verdigris-green, sometimes pistachio or apple-green. Streak greenish-white. Not very brittle. H = 6·0. G = 2·62...3·0.

In the matrass yields water, decrepitates and grows black. Infusible before the blowpipe; the point of the flame is coloured green. With borax and salt of phosphorus forms a transparent glass which shows the colour of iron while hot, and that of copper when cold. Soluble in hydrochloric acid.

Analyses of turquoise *a* from Jordansmühle by John, *b* by Zellner, from Persia (blue) *c*, (green) *d* by Hermann:—

	a	b	c	d
Phosphoric acid	30·90	38·90	27·34	5·64
Alumina	44·50	54·50	47·45	50·75
Oxide of copper	3·75	1·50	2·02	1·42
Oxide of iron	1·80	2·80	1·10	1·10
Oxide of manganese	—	—	0·50	0·60
Phosphate of lime ($\dot{\mathrm{C}}\mathrm{a}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}$) . .	—	—	3·41	18·10
Water	19·00	1·00	18·18	18·13
Silica	—	—	—	4·26

Is found in reniform and botryoidal masses, disseminated, and in pebbles, at Nischabur in Persia, Tibet, Jordansmühle and Domsdorf in Silesia, Nieski in Lusatia, Oelsnitz, Plauen and Reichenbach in Saxony.

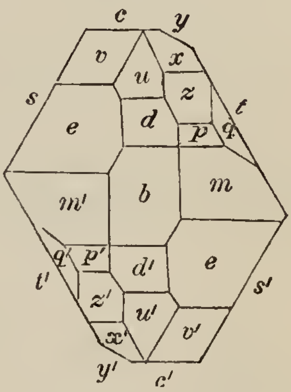
357. KLAPROTHINE.—Lazulit; Hauy, Phillips. Prismatischer Lasur-Spath; Mohs. Lazulith; Hausmann, Haidinger.

Oblique. 101,100 = 29° 25′; 111,010 = 50° 10′; 101,001 = 58° 50′.

a 100 twin-face, *b* 010, *c* 001, *d* 011, *u* 012, *t* 101, *y* 103, *s* $\bar{1}01$, *m* 110, *p* 111, *z* 112, *x* 113, *e* $\bar{1}11$, *v* $\bar{1}13$, *q* 212.

cb	90°	0′	*xx′*	128°	0′	*tx*	38°	22′
ab	90	0	*st′*	59	40	*tz*	37	32
ac	88	15	*ee′*	99	40			
tc	58	50	*vv′*	127	5			
ta	29	25	*qq′*	134	44			
yc	29	45	*xc*	39	40			
sc	61	30	*zc*	50	50			
sa′	30	15	*pc*	67	2			
uu′	99	30	*mc*	89	37			
dd′	61	25	*ec*	68	23			
mm′	91	30	*vc*	38	57			
pp′	100	20	*pe*	82	30			
zz′	115	30	*vx*	54	45			

FIG. 516.



Combinations. *bpets*, *petzc*, *stycbdumxzpevq*. Fracture uneven. Transparent...opaque. Lustre vitreous. Blue of various shades. Pleochromatic. Streak white. Very brittle. H = 5·0...5·5. G = 3·0...3·121.

In the matrass yields water and loses its colour. Before the blowpipe intumesces but does not melt. The flame is coloured slightly green. With solution of cobalt becomes blue. Is not acted upon by acids previous to ignition. After ignition is almost entirely dissolved.

$2\dot{R}\overset{\cdot\cdot\cdot\cdot\cdot}{P} + \overset{\cdot\cdot\cdot}{Al}\overset{\cdot\cdot\cdot\cdot\cdot}{P}^3 + 6\dot{H}$, where $\dot{R}$ is $\dot{M}g$, $\dot{F}e$, $\dot{C}a$.

Analyses of klaprothine *a* from Rädelgraben by Fuchs, *b*, *c*, *d*, *e*, *f*, of a dark blue variety from the Fishbach Alp, G = 3·11, by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*
Phosph. ac. . . .	42·74	42·41	43·84	46·99	41·33	47·04
Alumina	36·51	29·58	33·09	27·62	32·68	26·92
Magnesia	9·54	10·67	9·00	11·19	9·54	10·67
Lime	—	1·12	1·44	2·12	0·77	1·21
Protox. iron . . .	2·70	10·60	6·69	6·47	9·54	7·84
Water	6·19	5·62	5·94	5·61	6·14	6·32

Analyses of light-coloured klaprothine from Freschnitzgraben, G = 3·02, by Rammelsberg:—

Phosphoric acid . . .	40·95	47·36	47·73
Alumina	36·22	30·05	27·48
Magnesia	12·85	12·20	12·16
Lime	1·42	1·65	4·32
Protoxide of iron . .	1·64	1·89	1·91
Water	6·92	6·85	6·40

In the analyses which exhibit a larger proportion of alumina, the alumina contains some phosphoric acid. A variable mechanical admixture of silica, 0·53...12·56 per cent. is not included in the analyses.

Is found in crystals, but more frequently massive, at Rädelgraben not far from Werfen, and Rathhausberg in Salzburg, on the Fischbach Alp, and in Freschnitzgraben not far from Krieglach in Stiria, at the foot of the Wechsel near Therenberg in Lower Austria, Tijuco in Minas Geraes in the Brazils.

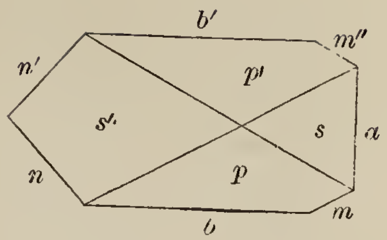
358. STRUVITE.—Struvite; Dufrénoy. Struvit; Hausmann.

Prismatic. 011,010 = 41° 35′; 101,001 = 31° 34′; 110,100 = 61° 25.

a 100, *b* 010, *p* 011, *s* 101, *m* 110, *n* 120, *t* 111. The forms *a*, *s*, *t* are usually, the forms *m*, *n* are always hemihedral with inclined faces. The faces *a*, *m* occur on one side of a plane parallel to *a*, and the faces *s*, *n* on the other side.

pb	41°	35′	ta	67°	50′
pp'	96	50	tp	22	10
sa	58	26	tb	46	9
ss'	63	8	ts	43	51
mb	28	35	tm	22	10
nb	47	28	mm''	122	50
ab	90	0	nn''	85	4

FIG. 517.



Combinations. bs, $ba's^{\backprime}$, $basn^{\backprime}$, $bpm'n^{\backprime}$, $bpa'm'n^{\backprime}$, $bpsa'n^{\backprime}$, $bpa'm'n^{\backprime}s^{\backprime}$. Twins. Twin-face *a*. Cleavage. *b*, perfect. Fracture conchoidal. Transparent...semi-transparent. Lustre vitreous. R = 1·52. The optic axes are in a plane parallel to *a*, and, when seen in air through the faces *bb′*, make angles of 29° 45′ with a normal to *b*. Colourless, yellow, brown. Streak white. H = 1·5...2·0. G = 1·66...1·75. Pyroelectric, the analogous pole being at the end on which the hemihedral face *a* occurs; the antilogous pole at the opposite end of the crystal.

In the matrass yields water and ammonia. Before the blowpipe melts into a colourless glass which becomes opaque on cooling. Very slightly soluble in water. Soluble in hydrochloric acid.

$\dot{\mathrm{M}}\mathrm{g}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}} + \mathrm{NH}^3 + 13\dot{\mathrm{H}}$, phosphoric acid 28·9, magnesia 16·7, ammonia 6·9, water 47·5. Part of the magnesia is sometimes replaced by protoxide of iron.

Struvite was found in crystals in 1845, in digging the foundations of the new church of St. Nicholas at Hamburgh, where it had evidently been produced by the decomposition of animal matter; also in guano from the coast of Africa (guanite). It is deposited as a granular precipitate from neutral or alkaline solutions containing phosphoric acid, ammonia and magnesia.

359. PLOMBGOMME.—Plombgomme; Phillips. Plomb hydro-alumineux; Hauy. Bleigummi; Mohs, Hausmann, Haidinger.

Reniform, botryoidal. Fracture conchoidal. Translucent. Lustre resinous, inclining to vitreous. Yellow, brown. Streak white. H = 5. G = 4·88...6·421.

In the matrass decrepitates and yields water. Before the blowpipe or charcoal melts with intumescence. With soda yields lead. With nitrate of cobalt becomes blue. Soluble in concentrated nitric acid.

Analyses of plombgomme *a* from Huelgöet by Damour, *b* from Beaujeu by Dufrénoy:—

	a	b
Phosphate of oxide of lead	—	7·79
Phosphoric acid	8·06	—
Oxide of lead	35·10	37·51
Alumina	34·32	34·23
Red oxide of iron	0·20	—
Lime	0·80	—
Chloride of lead	2·27	—
Sulphuric acid	0·30	$\bar{Si}$ 2·11
Water	18·70	16·13

So found in the lead mines of Huelgöet near Poullaouen in Bretagne and at la Nussière near Beaujeu in France.

SULPHATES.

360. ANGLESITE.—Sulphate of lead; Phillips. Plomb sulphaté; Hauy. Prismatischer Blei-Baryt; Mohs. Bleivitriol; Hausmann. Anglesit; Haidinger.

Prismatic. 011,010 = 31° 21′; 101,001 = 52° 16′; 110,100 = 51° 49′.

a 100, *b* 010, *c* 001, *d* 012, *l* 014, *o* 101, *m* 110, *h* 430, *n* 210, *z* 111, *r* 112, *θ* 116, *t* 211, *y* 212, *p* 234, *ζ* 412.

bc	90°	0′	*hh′*	92°	43′	*θb*	74°	53′
ca	90	0	*zz′*	67	47	*θc*	19	22
ab	90	0	*zz″*	90	19	*pa*	67	51
dd′	78	45	*z′z″*	128	54	*pb*	41	1
ll′	44	40	*ra*	63	28	*pc*	54	18
oo′	104	31	*rb*	55	24	*ya*	45	3
mm′	76	22	*rc*	46	16	*yb*	63	19
nn′	115	6	*θa*	78	10	*yc*	56	51
						ta	36	40
						tb	59	20
						tc	71	55
						ζa	23	1
						ζb	73	29
						ζc	73	7

FIG. 518.

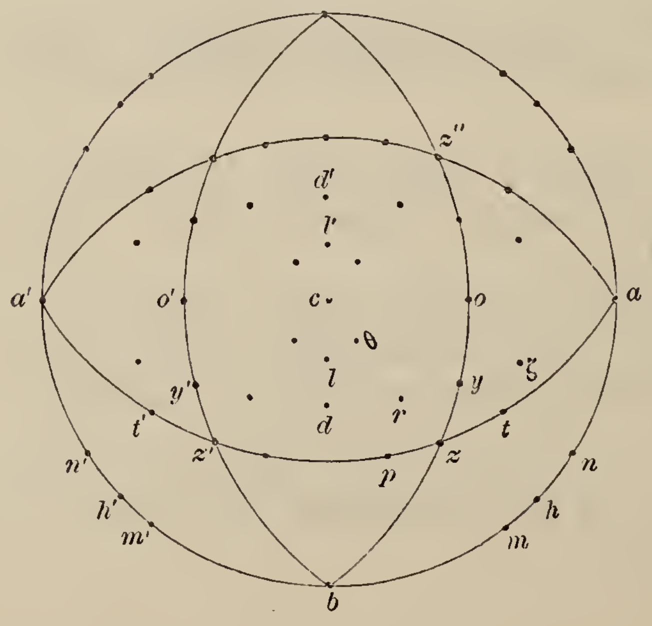
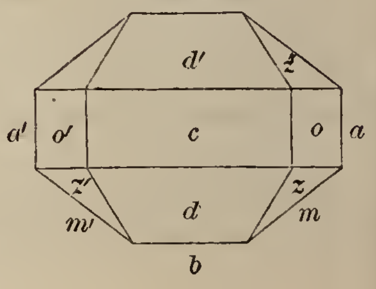


FIG. 519.



Combinations. *md..a.z.o.c.b*, *zodc.m.l*, *zpdc*, *noyhzc.θ.b*, *ζomzd*, *toymzdc*, *zoyrdcb*. Cleavage. *m*, *c*, both imperfect; *a*, traces. Fracture conchoidal. Transparent...translucent. Lustre adamantine, inclining to resinous or vitreous. R = 1·925. Colourless, yellowish, grey, brown, blue, green. Streak white. Brittle. H = 3·0. G = 6·26...6·30.

Decrepitates when heated. Before the blowpipe on charcoal in the outer flame melts into a clear bead, which becomes milk-white on cooling; in the inner flame is reduced. With soda and silica yields the reaction of sulphur. Slightly soluble in nitric acid. In powder is completely soluble in potash.

$\dot{Pb}\dddot{S}$, sulphuric acid 26·39, oxide of lead 73·61.

Analyses of anglesite *a* from Anglesea, *b* from Wanlockhead by Klaproth, *c* from Zellerfeld by Stromeyer:—

	a	*b*	*c*
Sulphuric acid	24·8	25·75	26·09
Oxide of lead	71·0	70·50	72·47
Red ox. iron	1·0	—	—
Hydrate of ox. iron	—	—	0·09
Oxide of manganese	—	—	0·07
Silica	—	—	0·51
Water	2·0	2·25	0·12

It sometimes contains a small quantity of silver.

In attached crystals and massive, pseudomorphous after galena; in veins of lead and silver ores with galena, copper pyrites, brown iron ore. It is evidently produced by the decomposition of galena.

Is found at Wolfach, Schapbach and Badenweiler in Baden, Müsen and Littfeld in Siegen, Tarnowitz in Silesia, Clausthal and Zellerfeld in the Harz, Bukowina, Linares in Spain, Beresowsk in Siberia, Southampton in Massachusetts, the lead mines of Missouri, Paris mine in Anglesea, Velenoweth near St. Ives in Cornwall, Wanlockhead and Lead Hills in Scotland.

361. CELESTINE.—Celestine; Phillips. Strontiane sulfateé; Hauy. Prismatoidischer Hal-Baryt; Mohs. Cölestin; Hausmann, Haidinger.

Prismatic. 011,010 = 31° 19′; 101,001 = 52° 4′; 110,100 = 52° 1′.

a 100, *b* 010, *c* 001, *e* 034, *d* 012, *g* 013, *l* 014, *o* 101, *i* 103, *ξ* 1 0 12, *m* 110, *n* 210, *z* 111, *f* 113, *q* 114, *y* 212, *ψ* 313, *χ* 414, *x* 315, *s* 312, *π* 413.

bc	90°	0′
ca	90	0
ab	90	0
ec	50	57
ee′	101	54
dd′	78	49
gc	28	43
gg′	57	26
lc	22	22
ll′	44	44
oc	52	4
oo′	104	8
ic	23	9
ii′	46	18

ξc	6°	6′
ma	52	1
mm′	75	58
na	32	38
nn′	114	44
zz′	67	25
zz″	90	34
z′z″	128	44
fa	69	27
fb	63	17
fc	34	47
qa	73	29
qb	68	39
qc	27	31

ya	45°	15′
yb	63	12
yc	56	43
yo	26	48
sa	33	55
sb	64	28
sc	69	15
ψa	41	38
ψb	71	24
ψc	54	22
χa	40	7
χb	75	50
χc	53	25
πa	33	41
πb	50	0
πc	69	23
xa	53	49
xb	75	24
xc	39	56

FIG. 520.

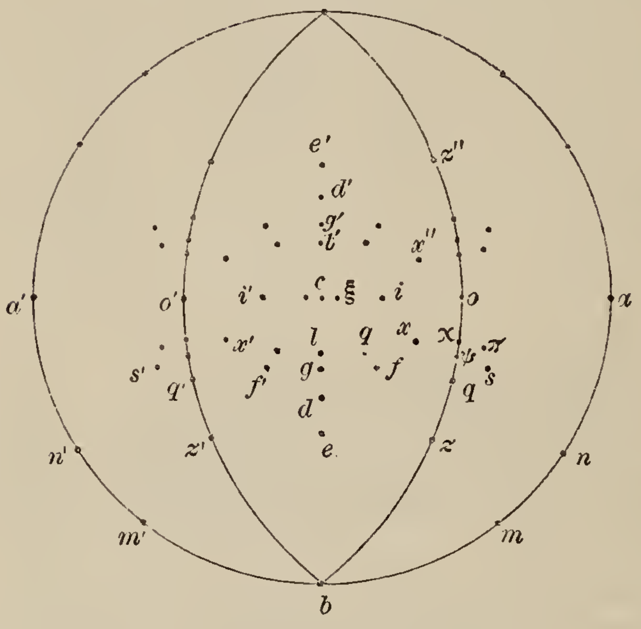
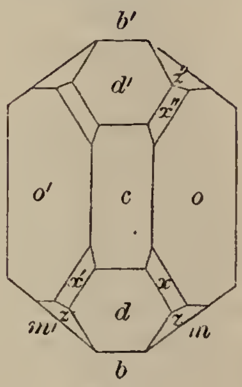


FIG. 521.



Combinations. *om.c.d.z, ox.d.c, odb, ocd.m, ocmzd..f.i.g.b.x.l, oymzdlc.* The faces *a* usually rough; *o* sometimes striated parallel to their intersections with *z* and *m;* the faces *b* striated parallel to their intersections with *m*. Cleavage. *c*, very perfect; *m*, less easily obtained, often interrupted by fracture; *a*, yet less distinct; *b*, traces. Fracture imperfect conchoidal. Transparent...translucent. Lustre vitreous, inclining to pearly on the surfaces of perfect cleavage. Colourless, white, grey, blue, flesh-red. Brittle. H = 3·0...3·5. G = 3·85...4·00.

Decrepitates when heated. Before the blowpipe on charcoal melts without difficulty in the outer flame into a white alcaline bead, which, in the inner flame, spreads upon the charcoal and forms a hepar. When this hepar is dissolved in hydrochloric acid, evaporated to dryness and placed on a strip of paper moistened with alcohol, when ignited it burns with a red flame. With borax fuses with effervescence into a clear glass, which becomes yellow or brown on cooling. With soda sinks into the charcoal and forms a hepar. Insoluble in hydrochloric acid. Phosphoresces when thrown in powder on a hot iron.

$\dot{Sr}\dddot{S}$, sulphuric acid 43·65, strontian 56·35.

Analyses of celestine *a* from Girgenti, *b* from Süntel near Münder, *c* (fibrous) from Dornburg, all by Stromeyer, *d* from Dornburg by Madrell, *e* from near Brunswick by Leonhardt, *f* from Fassathal by Brandes:—

	a	*b*	*c*	*d*	*e*	*f*
Sulphuric acid .	43·08	42·74	42·95	43·76	41·23	92·15
Strontian . . .	56·35	55·18	56·27	54·73	53·90	
Barytes . . .	—	0·86	—	sulph. bar.		1·87
Lime	—	0·31	—	1·42	1·12	—
Alumina . . .	—	—	0·05	—	—	—
Red ox. iron . .	0·03	0·04	0·03	—	1·88	0·50
Carbon. lime . .	0·09	0·02	0·10	—	—	1·83
Silica	—	—	—	(not decomp.	0·94)	1·00
Water	0·18	0·05	0·11	—	0·49	—

Is found in crystals, and in fibrous and compact masses, in the sulphur mines at Girgenti, Mazzara and Cataldo in Sicily, in sulphur at St. Beat in France; in limestone at Herrengrund in Hungary, Strontian Island in Lake Erie, Dornburg near Jena, near Bristol; in metallic veins at Scharfenberg near Meissen, and at Leogang in Salzburg; at Montecchio Maggiore in amygdaloid; at Bex in Switzerland, Conil in Spain, Calton Hill near Edinburgh; in the interior of fossil bivalves in the oolitic formation of the Weser.

362. BARYTE.—Barytes; Phillips. Baryte sulfatée; Hauy. Prismatischer Hal-Baryt; Mohs. Baryt; Hausmann, Haidinger.

Prismatic. 011,010=31° 49′·4; 101,001=52° 42′; 110,100=50° 50′.

a 100, *b* 010, *c* 001, *u* 011, *d* 012, *g* 013, *l* 014, *σ* 015, *w* 016, *o* 101, *φ* 102, *m* 110, *n* 210, *η* 230, *λ* 120, *z* 111, *r* 112, *f* 113, *q* 114, *v* 115, *k* 118, *y* 212, *s* 312, *μ* 214, *γ* 132.

bc	90°	0′	*uu′*	116°	21′	*gg′*	56°	28′
ca	90	0	*dd′*	77	43	*ll′*	43	53
ab	90	0	*gc*	28	14	*σσ′*	35	44

ww′	30°	4′	*ra*	62°	56′	*vc*	22°	34′
oo′	105	24	*rb*	56	2	*ka*	80	52
φφ′	66	34	*rc*	46	6	*kb*	78	45
ma	50	50	*fa*	68	55	*kc*	14	34
mm′	78	20	*fb*	63	48	*sa*	33	7
nn′	116	55	*fc*	34	43	*sb*	69	57
ηη′	57	0	*qa*	73	4	*sc*	64	49
λλ′	44	20	*qb*	69	3	*ya*	44	23
za	55	19	*qc*	27	27	*yb*	63	58
zb	45	41	*va*	75	58	*yc*	57	0
zc	64	18	*vb*	72	41	*μa*	58	40
						μb	71	23
						μc	37	36
						γa	75	55
						γb	26	20
						γc	68	14

FIG. 522.

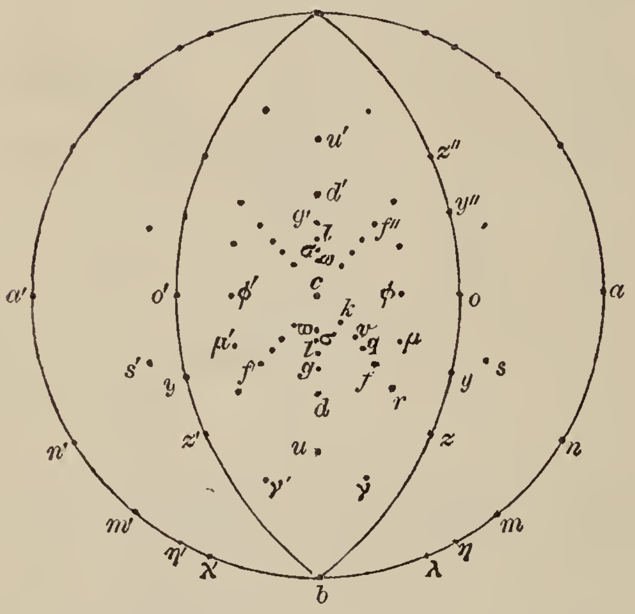
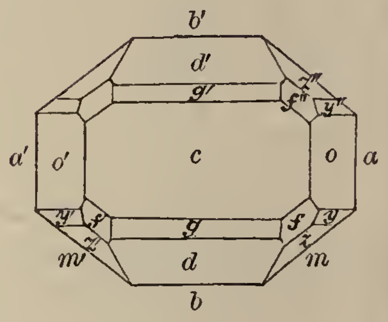


FIG. 523.



Combinations. *mc..a.n.η.b.o.y.z*, *md..c.o.γ*, *od..a.z.m.y.c.b*, *mcd..a.o.s.y.z.u*, *ocd..m.z*, *boud..z.m.c*, *oadc..u.f.v.g.σ*, *omdc..a.y.z.f.b.g*. Cleavage. *m*, *c*, perfect, *c* usually more readily obtained than *m*; *a*, less perfect; *b*, still less perfect; *z*, *d*, traces. Fracture conchoidal, seldom observable. Transparent...translucent. Lustre vitreous, inclining to resinous. R = 1·6468, 1·6352. Colourless, white, grey, blue, yellow, red. Streak white. Brittle. H = 3·0...3·5. G = 4·35...4·59.

Decrepitates when heated. Before the blowpipe in the inner flame is reduced to sulphuret of baryum, and becomes alkaline, imparting a yellowish-green colour to the flame. With borax melts into a clear glass which becomes yellow or brown on cooling. With soda forms a hepar, and sinks into the charcoal. With soda and silica yields a yellow or brown bead. Insoluble in hydrochloric acid.

$\dot{\mathrm{Ba}}\overset{\cdots}{\mathrm{S}}$, sulphuric acid 34·37, barytes 65·63. Part of the barytes is sometimes replaced by strontian.

Analyses of baryte *a* from Freiberg by Klaproth, *b* from

Nutfield by Stromeyer, *c* a colourless crystal, G = 4·4864, from Silbach, *d* in brownish-yellow crystals, G = 4·488, from Görzing, both by Rammelsberg, *e* granular from Wiesbaden by Fresenius, *f* compact from Clausthal by Jordan:—

	a	*b*	*c*	*d*	*e*	*f*
Sulphate barytes . .	97·50	99·38	99·4	83·48	89·47	86·00
Sulphate strontian .	0·85	—	0·6	15·12	1·85	6·75
Red ox. iron . . .	—	0·05	—	—	0·29	—
Sulph. lime	—	—	—	0·89	—	—
Silica	0·80	—	—	0·25	8·15	5·75
Water	0·70	0·07	—	—	0·08	0·38

In crystals, fibrous, compact and earthy masses; pseudomorphous after witherite and barytocalcite; forming the substance of ammonites, belemnites, fossil wood; in beds and veins in various formations.

Is found at Silbach in Westphalia, at Clausthal, Zellerfeld and other places in the Harz, Freiberg, Marienberg in Saxony, Przibram, Mies, Töplitz, Teschen and the Giftberg in Bohemia, Kremnitz and Felsöbanya in Hungary, Kapnik in Transylvania, Champeix and Puy de la Courtade in Auvergne, and near Nantes in France, Wiesloch and Wittichen in Baden, Bieber in Hessia, Dufton in Cumberland, Nutfield in Surrey, in Staffordshire and Derbyshire, the Tyrol, Stiria, Carinthia, Bologna. Hepatite is a variety of baryte from Kongsberg in Norway, and Andrarum in Schonen, containing a small quantity of carbonaceous matter.

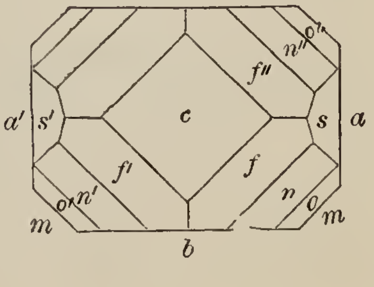
363. KARSTENITE.—Anhydrite; Phillips. Chaux anhydro sulfatée; Hauy. Prismatisches Euklas-Haloid; Mohs. Karstenit; Hausmann, Haidinger.

Prismatic. 011,010=42° 17′; 101,001=44° 25′; 110,100=48° 18′.

a 100, *b* 010, *c* 001, *s* 101, *m* 110, *o* 111, *n* 112, *f* 113.

bc	90°	0′	*oc*	55°	50′
ca	90	0	*os*	38	9
ab	90	0	*na*	66	45
sc	44	25	*nb*	63	43
ss′	91	10	*nc*	36	23
ma	48	18	*fa*	72	56
mm′	83	24	*fb*	70	47
oa	56	36	*fc*	26	10
ob	51	51			

FIG. 524.



Combinations. *abc*, *abcm*, *abconf*, *abcmonf*. *b*, rough; the other faces smooth. Cleavage. ∥ *a*, *c*, very perfect; *b*, less perfect, yet easily obtained. Fracture imperfect conchoidal. Transparent...translucent. Lustre vitreous, on the most perfect cleavages pearly. The optic axes are in a plane parallel to the face *c*, and make angles of 21° 46′ with a normal to *b*. The indices of refraction of light in planes parallel to *a*, *c*, *b*, and polarized in those planes respectively, are 1·571, 1·576, 1·614. Colourless, white, inclining to grey, yellow, red, blue. Streak greyish-white. Brittle. H = 3·0...3·5. G = 2·85...3·05.

Before the blowpipe melts with difficulty into a white enamel; on charcoal in the inner flame yields a hepar. With borax dissolves into a clear glass which is yellow when cold. With fluor melts easily into a clear bead. With soda forms a hepar. Is very slightly soluble in water and in hydrochloric acid.

$\dot{\mathrm{Ca}}\dddot{\mathrm{S}}$, sulphuric acid 58·82, lime 41·18.

Analyses of karstenite *a* from Sulz by Klaproth, *b* from Ihlefeld, *c*, *d* from Vulpino by Stromeyer, *e* from Eisleben by V. Rose:—

	a	*b*	*c*	*d*	*e*
Sulphuric acid	59·78	55·80	56·78	58·01	56·28
Lime	43·06	40·67	41·51	41·70	41·48
Red oxide of iron . . .	0·10	0·25	0·03	—	—
Silica	0·25	0·23	0·26	0·09	—
Water	—	2·91	0·94	0·07	0·75
Carbon. acid and bitumen	—	0·13	—	—	—

In attached crystals; fibrous and contorted masses; in beds and veins with metallic sulphides, and in the clay which accompanies rock salt and gypsum.

Is found at Aussee in Styria, Hall in the Tyrol, Hallein in Salzburg, Berchtesgaden, Ischel, at Bex and Val Canaria in Switzerland, Vic in Lorraine, Pesey in Savoy, Vulpino in Italy, Osterode and Eisleben, Segeberg, Lüneberg, Tiede, Sulz, in the salt mines of Wieliczka and Bochnia, Lockport in New York. In veins with metallic sulphides at Riechelsdorf, Lauterberg in the Harz, Kapnik, Bleiberg, Fahlun.

364. GLAUBERITE.—Glauberite; Phillips, Hauy. Hemiprismatisches Brithyn-Salz; Mohs. Brongniartin; Hausmann. Glauberit; Haidinger.

Oblique. 101,100 = 37° 23′; 111,010 = 58° 10′; 101,001 = 30° 53′.

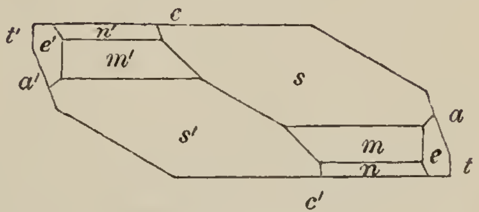
a 100, *c* 001, *t* $20\bar{1}$, *z* $30\bar{2}$, *m* 110, *s* 111, *n* $11\bar{1}$,

e $31\bar{1}$, v $11\bar{3}$, x $33\bar{1}$. z truncates the edge tc'; v, x truncate the edge mc'.

ca	68°	16′
ta	35	21
za	46	14
mm′	83	20
ma	48	20
ss′	116	20
nn′	95	22
ee′	136	8
xx′	79	10
vv′	142	44
sc	43	11

mc	75°	45′
xc	91	3
nc	119	8
vc	155	31

FIG. 525.



Combinations. *cs*, *csm*, *csma*, *cstnema*. The faces *c*, *s* striated parallel to their intersections with each other. Cleavage. *c*, perfect; *m*, traces. Fracture conchoidal...uneven. Semitransparent...translucent. Lustre vitreous, on the cleavages inclining to pearly, on the surface of fracture inclining to resinous. At the ordinary temperature of the atmosphere the optic axes for violet light coincide, the axes for the other rays being double. Colourless, greyish-white, yellowish-white, red. Streak white. Brittle. H = 2·5...3·0. G = 2·7...2·8. Taste slightly saline and astringent.

Decrepitates when heated. Before the blowpipe on charcoal, in the inner flame, melts into an alkaline hepatic bead. Partially soluble in water, leaving a residue of sulphate of lime. When exposed to moist air becomes covered with an opaque white crust.

$\dot{\mathrm{Na}}\dddot{\mathrm{S}} + \dot{\mathrm{Ca}}\dddot{\mathrm{S}}$, sulphuric acid 57·56, soda 22·29, lime 20·15.

Analyses of glauberite from Villarubia *a* by Brongniart, *b* from Vic by Dufrénoy, *c* from Berchtesgaden by v. Kobell:—

	a	*b*	*c*
Sulphate of soda	51	48·50	48·6
Sulphate of lime	49	46·60	51·0
Chloride of sodium . . .	—	1·20	—
Clay	—	2·7	—

Is found in crystals and reniform masses, imbedded in rock salt, at Villarubia near Ocaña in Spain, Vic in Lorraine, Berchtesgaden in Bavaria, Atacama, Chile. It is said to have been found also at Müllingen in Switzerland.

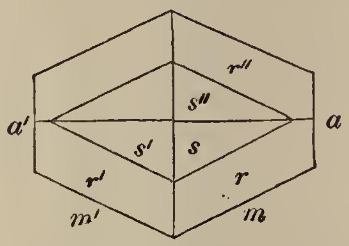
365. THENARDITE.—Thenardite; Phillips, Beudant. Thenardit; Mohs, Hausmann, Haidinger.

Prismatic. 011,010=40° 41′; 101,001=28° 50′; 110,100=64° 40′·5.

a 100, *c* 001 cleavage, *m* 110, *r* 111, *s* 113.

ac	90°	0′
mc	90	0
mm′	50	39
rr′	44	19
rr″	105	42
r′r″	123	43
sm	58	4

FIG. 526.



Combinations. *rc*, *rm*, *rcm*, *amrs*. Cleavage. *c*, perfect; *m*, imperfect. Fracture conchoidal. Transparent...translucent. Lustre vitreous. Colourless, white. H = 2·5. G = 2·67...2·73.

Imparts a bright yellow colour to the blowpipe flame. On charcoal melts into an alkaline hepar. Soluble in water. Attracts moisture from the air and becomes covered with a white powder.

$\dot{\mathrm{Na}}\dddot{\mathrm{S}}$, sulphuric acid 56·36, soda 43·64.

Analysis by Casaseca :—

Sulphate of soda	99·78
Carbonate of soda	0·22

Is found in crystals in the brine springs at Salinas d'Espartinas not far from Madrid. A concentrated solution of sulphate of soda affords crystals of thenardite at 33° C.

Seleniate of soda and sulphate and seleniate of oxide of silver are isomorphous with thenardite. In seleniate of soda, $\dot{\mathrm{Na}}\dddot{\mathrm{Se}}$, selenic acid 67·26, soda 32·74, *rr′* = 45° 38′, *r′r″* = 123° 43′. In sulphate of oxide of silver, $\dot{\mathrm{Ag}}\dddot{\mathrm{S}}$, sulphuric acid 25·65, oxide of silver 74·35, *rr′* = 43° 40′, *r′r″* = 125° 11′. In seleniate of oxide of silver, $\dot{\mathrm{Ag}}\dddot{\mathrm{Se}}$, selenic acid 35·44, oxide of silver 64·56, *rr′* = 44° 18′, *r′r″* = 123° 30′.

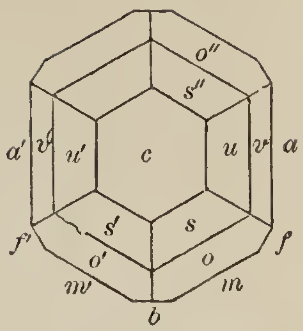
366. GLASERITE.—Sulphate of potash; Phillips. Potasse sulfatée; Hauy. Prismatisches Pikrochylin-Salz; Mohs. Glaserit; Hausmann. Arcanit; Haidinger.

Prismatic. 011,010 = 37° 30′; 101,001 = 36° 44′; 110,100 = 60° 12′.

a 100, *b* 010, *c* 001, *e* 012, *u* 101, *v* 201, *m* 110, *f* 310, *o* 111, *s* 112. *e* truncates the edge *ss′*.

FIG. 527.

bc	90°	0′	*ff′*	119°	36′
ca	90	0	*oo′*	48	52
ab	90	0	*oo″*	92	29
ee′	66	10	*o′o″*	112	41
uu′	73	29	*ss′*	34	44
vv′	112	22	*ss″*	62	48
mm′	59	36	*s′s″*	73	48



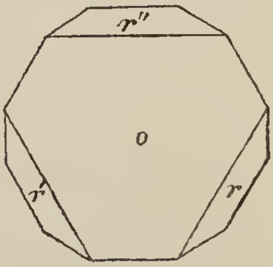
Combinations. *cam*, *oamv*, *ocaumsv*, *ocaumfsv*. Twins. Twin-face *m*. Cleavage. *c*, imperfect; *a*, *m*, still more imperfect. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous. Colourless, white, yellowish or greyish. Streak white. Rather brittle. H = 2·5...3·0. G = 2·689...2·709.

Decrepitates when heated. Before the blowpipe on charcoal in powder fuses readily into an alkaline hepar. Soluble in 10 parts of water at 12° C, and in 3·95 parts at 100° C.

$\dot{K}\dddot{S}$, sulphuric acid 45·90, potash 54·10.

Is found on Vesuvian lavas and in solution in some springs.

FIG. 528.



Sulphate of potash is dimorphous. It has been observed by Mitscherlich in crystals belonging to the rhombohedral system. *o* 111, *r* 100. *ro* = 56° 0′, *rr′* = 91° 46′.

Sulphate of potash, seleniate of potash, chromate of potash, manganate of potash, and mascagnine, are isomorphous. In chromate of potash, $\dot{K}\dddot{\bar{C}r}$, chromic acid 52·46, potash 47·54, *vv′* = 111° 10′, *mm′* = 59° 56′. In seleniate of potash, $\dot{K}\dddot{Se}$, selenic acid 57·46, potash 42·54, *vv′* = 111° 48′·5, *mm′* = 59° 35′. Twin crystals of chromate and seleniate of potash occur similar to those of sulphate of potash. In manganate of potash, $\dot{K}\dddot{Mn}$, manganic acid 52·24, potash 47·76. *vv′* = 113° 0′, *mm′* = 58° 49′·5.

367. MASCAGNINE.

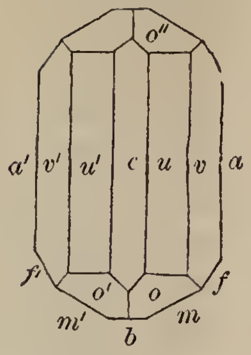
—Sulphate of ammonia; Phillips. Ammoniaque sufatée; Hauy. Prismatisches Ammoniak-Salz; Mohs. Mascagnin; Hausmann, Haidinger.

Prismatic. 011,010 = 37° 40′; 101,001 = 36° 10′; 110,100 = 60° 34′.

a 100, *b* 010, *c* 001, *u* 101, *v* 201, *m* 110, *f* 310, *o* 111.

bc	90°	0′	*fa*	30°	34′
ca	90	0	*ff′*	118	52
ab	90	0	*oa*	65	57
uu′	72	20	*ob*	43	43
vv′	111	15	*oc*	56	5
ma	60	34	*oo′*	48	6
mb	29	26	*oo″*	92	34
mm′	58	52	*o′o″*	112	10

FIG. 529.



Combinations. *amu*, *baimu*, *omua*, *omuvfa*. Cleavage. *a*, perfect; *b*, imperfect; *c*, traces. Fracture imperfect conchoidal. Transparent...translucent. Lustre vitreous. Colourless, white, grey, yellow. Streak white. Sectile. H = 2·0...2·5. G = 1·68...1·78. Taste pungent and bitter.

$NH^4O\overset{\cdots}{S}$, sulphuric acid 60·59, oxide of ammonium 39·41.

In the matrass yields water, with potash emits a smell of ammonia. Is completely volatilized before the blowpipe. Is soluble in two parts of cold, and in one of boiling water.

It is a volcanic product, and occurs in crystals, stalactites, and investing other minerals, on Vesuvius, Ætna, the Solfatara of Pozzuolo, in the Lipari islands, in the water of the Lagunes of Tuscany. It is formed in coal mines at Aubin in Aveyron, and Bradley in Staffordshire.

HYDROUS SULPHATES.

368. GYPSUM.

—Gypsum; Phillips. Chaux sulfatée; Hauy. Prismatoidisches Euklas-Haloid; Mohs. Gyps; Hausmann, Haidinger.

Oblique. 101,100 = 52° 16′; 111,010 = 71° 51′; 101,001 = 28° 16′.

a 100, *b* 010, *v* 011, *t* $\bar{1}01$, *d* 101 twin-face, *e* $\bar{1}03$, *m* 110, *h* 120, *k* 130, *l* 111, *y* 131, *n* $\bar{1}11$, *x* $\bar{1}21$, *s* $\bar{1}31$, *u* $\bar{1}33$, *w* $\bar{1}13$.

ab	90°	0′	*ll′*	143°	42′	*nb*	69°	14′
tb	90	0	*yb*	45	39	*nn′*	138	28
da	52	16	*vb*	67	47	*xb*	52	50
ea	92	2	*vv′*	135	34	*sb*	41	19
ta	113	46	*wb*	82	8	*ma*	34	19
ta′	66	14	*ub*	67	30	*mb*	55	41
lb	71	51	*uu*	135	0	*mm′*	111	42

hb	36°	12′	*nu*	20°	15′
kb	26	1	*uv′*	10	38
la	54	25	*vl*	26	49
nl	57	43	*lm*	49	0
na′	67	52	*nm′*	59	16

FIG. 531.

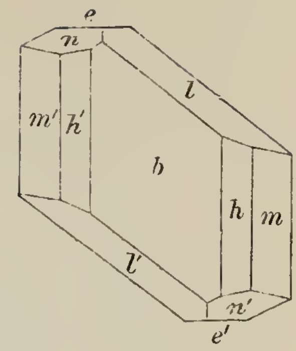


FIG. 530.

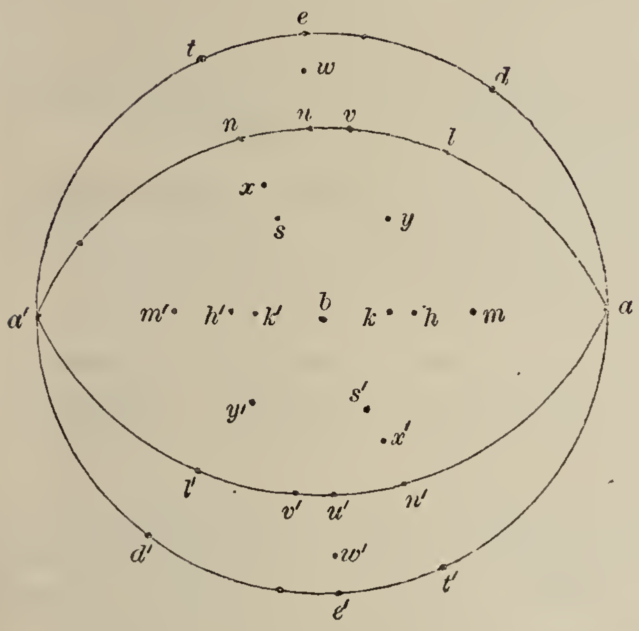


FIG. 532.

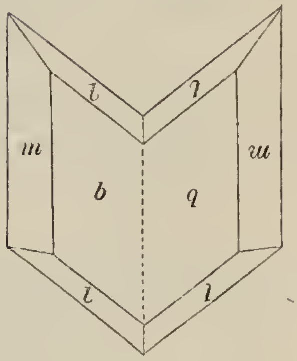
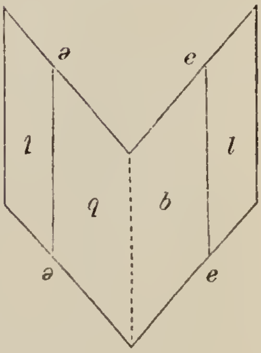


FIG. 533.



An increase of temperature of 100° c, increases *mb* 5′·4, *lm* 4′·2, and diminishes *da* 7′·4. Combinations. *lmb.n*, *elmhb.n*, *elnsmb*, *elumb*, *elnuxsmhkb*. The faces *m*, *b* striated parallel to their intersections with each other; *n* frequently rough. Twins. 1. Twin-face *a* (fig. 532). 2. Twin-face *d* (fig. 533). The faces *l*, *e* in this twin are frequently convex, producing lenticular forms. Cleavage. *b*, very perfect and easily obtained; *n*, imperfect, fibrous; *a*, imperfect, conchoidal. Fracture seldom observable, flat conchoidal. Transparent...translucent. Lustre vitreous; *b*, pearly. R = 1·525...1·536. The rings surrounding the optic axes are dissimilar. At 9·4° c the optic axes lie in a plane parallel to *b*. One of them, the rings of which have dull colours, makes an angle of 6°46′ with a normal to *a*, and of 55°30′ with a normal to *d*. The other, with brighter coloured rings, makes an angle of 68° 10′ with a normal to *a*, and of 23° 52′ with a normal to *e*. At about 80° c the optic axes coincide in a line making an angle of 37° 28′ with a normal to *a*, and, on a further increase of temperature they again separate in a plane perpendicular to *b*. Colourless, red, yellow, blue, grey. Streak white. Sectile. Flexible in thin plates round a line parallel to the edge *tb*. H = 1·5...2·0. Least on *b*, greatest on *e*. G = 2·28...2·33.

In the matrass yields water. Before the blowpipe becomes opaque and white, and melts into a white alkaline enamel; on charcoal in the inner flame yields a hepar. With fluor melts into a clear bead which becomes opaque when cold. One part is soluble in 460 parts of water. Is hardly more soluble in acids. Is completely decomposed in a boiling solution of carbonate of potash. When exposed to a temperature of between 132° C and 150° C, the water escapes and it becomes friable. Mixed with water in this state it combines with the water, becomes hot, and grows hard. Exposed to a higher temperature it becomes incapable of combining with water.

$\dot{Ca}\dddot{S} + 2\dot{H}$, sulphuric acid 46·51, lime 32·56, water 20·93.

Analyses of gypsum *a* by Bucholz, *b*, *c* by V. Rose :—

	a	*b*	*c*
Sulphuric acid	46	44·16	44·25
Lime	33	33·88	33·75
Water	21	21·00	21·00

In attached and imbedded crystals; globular, granular, fibrous and compact masses; pulverulent. In beds in the new red sandstone, and occasionally in older rocks; in imbedded masses and groups of crystals in clay; in sulphur with celestine; in salt mines; in the rubbish of deserted mines; in the clay beds of the brown coal of some districts; pseudomorphous after karstenite and salt; in fossil shells; in peat bogs. Some varieties appear to have been recently crystallized.

Is found in crystals at Kleinschleppenstedt and Tiede near Brunswick, Grossalmerode in Hessia, Waltershausen in Thüringia, in the salt mines in the Tyrol, Salzburg, the Salzkammergut, Bex in Switzerland, Montmartre near Paris, Shotover Hill near Oxford, in the sulphur mine of Girgenti in Sicily, on the Irtisch in Siberia, near Oçana in Spain; in veins of ore at Wolfach, Leogang, Schemnitz. Fibrous and compact varieties are found at Jena, near Mansfeld, Wernigerode, Heilbronn, Stuttgard, between Nordhausen and the Harz, Lüneburg, Segeberg, near Volterra in Tuscany, in the new red sandstone formation in Yorkshire, Cheshire, Derbyshire, Nottinghamshire, Devonshire, &c., near Moffat and at Whittader in Scotland, in various parts of the United States.

Seleniate of lime, $\dot{Ca}\dddot{Se} + 2\dot{H}$, and sulphate of protoxide of iron with two equivalents of water, $\dot{Fe}\dddot{S} + 2\dot{H}$, are isomorphous with gypsum.

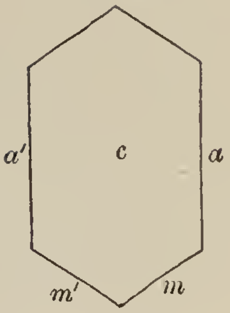
369. POLYHALITE. — Polyhalite; Phillips, Beudant. Prismatisches Brithyn-Salz; Mohs. Polyhalit, Hausmann, Haidinger.

Prismatic.

a 100, *c* 001, *m* 110.

ac	90°	0′
mc	90	0
ma	57	30
mm′	65	0

FIG. 534.



Combinations. *acm*. Cleavage. *m*, imperfect. Fracture uneven. Translucent. Lustre waxy, in the fibrous varieties silky. Red of various shades. Streak white. Rather brittle. H = 3·5. G = 2·73...2·78. Taste bitter and saline, feeble.

In the matrass yields water. Before the blowpipe on charcoal melts readily into an opaque reddish bead, which, on cooling, becomes white and alkaline. Partially soluble in water leaving a residue of sulphate of lime.

$\dot{\mathrm{K}}\dddot{\mathrm{S}} + \dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{S}} + 2\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{S}} + 2\dot{\mathrm{H}}$, sulphate of lime 45·2, sulphate of magnesia 20·1, sulphate of potash 28·8, water 5·9.

Analyses of polyhalite from Ischel *a* by Stromeyer, from Aussee *b* by Rammelsberg:—

	a	*b*
Sulphate of lime	44·74	45·43
Sulphate of magnesia . .	20·03	20·59
Sulphate of potash . . .	27·70	28·10
Chloride of sodium . . .	0·19	0·11
Chloride of magnesium .	0·01	—
Water	5·95	5·24
Red oxide of iron . . .	0·34	0·33
Silica	—	0·20

Is found with rock salt, in crystals, fibrous and compact masses, and pseudomorphous after rock salt, at Aussee in Stiria, Ischel in Austria, and Berchtesgaden in Bavaria.

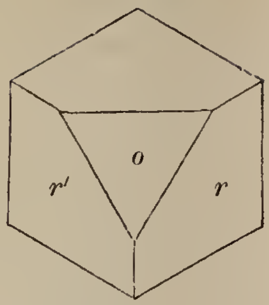
370. ALUNITE.—Alum-stone; Phillips. Alunite; Beudant. Rhomboedrisches Alaun-Haloid; Mohs. Alaunstein; Hausmann. Alunit; Haidinger.

Rhombohedral. 100,111 = 52° 45′.

o 111, *r* 100.

ro	52° 45′
rr′	87 10

FIG. 535.



Combination, *or*. The faces *r* sometimes striated parallel to their intersections with *o*; frequently curved. Cleavage. *o*, tolerably perfect; *r*, traces. Fracture uneven. Transparent...semi-transparent. Lustre vitreous, on *o* inclining to pearly. Colourless, white inclining to yellow, red, grey. Streak white. Brittle. H = 3·5...4·0. G = 2·69...2·80.

In the matrass yields water. The crystals decrepitate violently when heated. Infusible before the blowpipe. With soda forms a hepar. With solution of cobalt becomes blue. Soluble in hot concentrated sulphuric acid, and in a hot solution of potash. Insoluble in hydrochloric acid. Water extracts alum from it after ignition.

$\dot{K}\dddot{S} + 3\dddot{Al}\dddot{S} + 6\dot{H}$, sulphuric acid 38·56, alumina 37·07, potash 11·36, water 13·01.

Analyses of alunite *a* from Montione by Descotils, *b* from Tolfa by Cordier, *c* from Bereghszasz by Berthier:—

	a	*b*	*c*
Sulphuric acid . . .	35·6	35·50	39·42
Alumina	40·0	39·65	37·95
Potash	13·8	10·02	10·66
Water	10·6	14·83	11·97

Is found in attached crystals, and massive, at Tolfa near Civita Vecchia, Montione in Tuscany, Bereghszasz and Musay in Hungary, Puy de Sancy in France, and in the islands of Milo, Argentiera and Nevis.

371. ALUM.—Alum; Phillips. Alun; Beudant. Oktaedrisches Alaun-Salz; Mohs. Kalialaun; Hausmann. Alaun; Haidinger.

Cubic.

a 100, *o* 111, *d* 011.

aa′	90° 0′
oo′	70 32
oa	54 44
dd′	60 0
da′	45 0
do	35 16

FIG. 536.

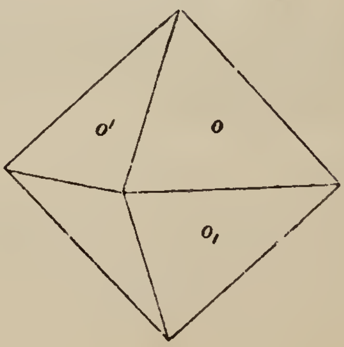
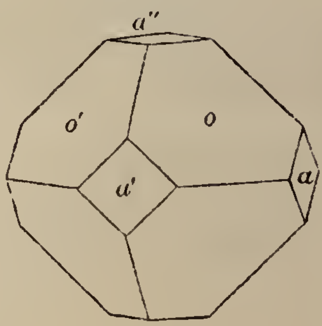


FIG. 537.



Forms and combinations. *a*, *o*, *ao*, *od*, *aod*. Twins. Twin-face *o*. Cleavage. *o*, imperfect. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous. $\mu = 1{\cdot}458$. White. Streak white. Rather brittle. H = 2·0...2·5. G = 1·9...2·0. Taste sweetish, astringent.

In the matrass melts, intumesces and yields a large quantity of water. When heated to redness, sulphurous acid is disengaged. The remainder moistened with nitrate of cobalt and ignited becomes blue. Soluble in 18·4 parts of cold water, and in 0·75 of boiling water. The solution yields a precipitate with ammonia and tartaric acid, and a yellow precipitate with chloride of platinum.

$\dot{K}\dddot{S} + \dddot{Al}\dddot{S}^3 + 24\dot{H}$, sulphuric acid 33·8, alumina 10·8, potash 9·9, water 45·5.

In crystals; more frequently as an efflorescence on aluminous rocks, lavas and burning coal mines.

Is found in the Lipari islands, Sicily, St. Michael in the Azores, the alum-slate rocks in Thuringia, Christiania in Norway, the burning mine at Duttweiler, Whitby in Yorkshire.

372. SODA-ALUM.—Alun sodifère; Dufrénoy. Natron alaun; Hausmann.

External characters the same as those of potash alum, except that G = 1·88.

Is more soluble in water than potash alum. The solution yields no precipitate with chloride of platinum, and after the precipitation of the alumina by ammonia, is not rendered turbid by the addition of phosphate of soda.

$\dot{Na}\dddot{S} + \dddot{Al}\dddot{S}^3 + 24\dot{H}$, sulphuric acid 34·9, alumina 11·2, soda 6·8, water 47·1.

Is found in the Neapolitan Solfatara, the island of Milo, north of Mendoza in the province of St. Juan on the east side of the Andes.

373. AMMONIA-ALUM.—Alun ammoniacal; Dufrénoy. Ammoniakalaun; Hausmann.

Cubic.

o 111.

oo′ 70° 32′ (fig. 536.)

Cleavage. *o*, imperfect. Fracture conchoidal. Translucent. Lustre vitreous. Colourless, greyish-white. H = 2·0...2·5. G = 1·753.

In the matrass yields a sublimate of sulphate of ammonia. Mixed with soda and heated yields an ammoniacal smell.

$NH^3\dot{H}\dddot{S} + \dddot{Al}\dddot{S}^3 + 24\dot{H}$, sulphuric acid 35·3, alumina 11·3, ammonia 3·8, water 49·6.

Analysis of ammonia-alum from Tschermig by Stromeyer:—

Sulphuric acid	36·06
Alumina	11·60
Ammonia	3·72
Magnesia	0·12
Water	48·39

Is found in crystals in clay at Saalfeld in Thuringia, massive in a bed of brown coal at Tschermig near Saatz in Bohemia.

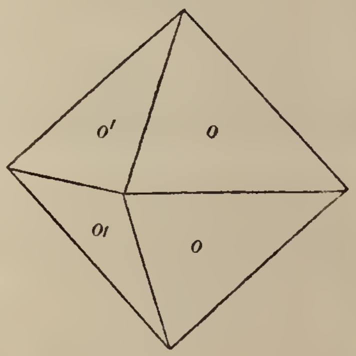
Ammonia with one equivalent of water, $NH^3\dot{H}$, is in other cases also found to be isomorphous with potash. The following salts, all of which crystallize in forms of the cubic system, resemble either potash-alum or ammonia-alum in their composition, red oxide of iron or oxide of chrome being substituted for alumina:—$\dot{K}\dddot{S} + \dddot{\cancel{Fe}}\dddot{S}^3 + 24\dot{H}$, $\dot{K}\dddot{S} + \dddot{\cancel{Cr}}\dddot{S}^3 + 24\dot{H}$, $NH^3\dot{H}\dddot{S} + \dddot{\cancel{Fe}}\dddot{S}^3 + 24\dot{H}$, $NH^3\dot{H}\dddot{S} + \dddot{\cancel{Cr}}\dddot{S}^3 + 24\dot{H}$.

374. VOLTAITE.—Voltaite; Dufrénoy. Voltait; Hausmann, Haidinger.

Cubic. *a* 100, *o* 111, *d* 011.

aa′	90°	0′
oo′	70	32
oa	54	44
dd′	60	0
do	35	16
da′	45	0

FIG. 538.



Fracture uneven. Lustre resinous. Black, inclining to brown and green. Streak greyish-green. Partially soluble in water.

Analyses by Abich and Dufrénoy:—

Sulphuric acid	48·32	45·67
Alumina	2·20	3·27
Red oxide of iron	17·65	—
Protoxide of iron	11·60	28·69

Potash	4·04	5·47
Soda	0·25	—
Water	15·94	15·77
Remainder	—	0·46

Is found in the Solfatara of Pozzuolo near Naples.

375. HALOTRICHITE.—Alumine sulfatée; Hauy. Halotrichit; Hausmann, Haidinger.

Fracture uneven. Translucent on the edges. Dull, glimmering. White, passing into grey and yellow. H = 2. Taste sweetish, astringent.

In the matrass intumesces and yields water, having an acid reaction. The residue is infusible before the blowpipe. With solution of cobalt becomes blue. Soluble in water.

$\overset{\cdots}{\mathrm{Al}}\overset{\cdots}{\mathrm{S}} + 18\dot{\mathrm{H}}$, sulphuric acid 36·0, alumina 15·4, water 48·6.

Analyses of halotrichite *a* from Pyromeni by Hartwall, *b* from Coquimbo by H. Rose, *c* from Kolosoruk, *d* from Friesdorf, *e* from Potschappel, *f* from Freienwald, by Rammelsberg:—

	a	*b*	*c*	*d*	*e*	*f*
Sulphuric acid . . .	40·31	36·97	35·82	37·38	35·71	35·64
Alumina	14·98	14·63	15·57	14·87	12·78	11·23
Protox. iron . . .	($\bar{\mathrm{F}}\mathrm{e}$	2·58)	—	2·46	0·67	0·72
Protox. mangan. . .	—	—	—	—	1·02	0·31
Magnesia	0·85	0·14	—	—	0·27	1·91
Soda	1·13	—	lime	0·15	0·64	0·45
Potash	0·26	—	—	0·21	0·32	0·47
Water	40·94	44·64	48·61	45·16	47·02	48·85
Hydrochloric acid .	0·40	—	—	—	—	—
Silica	1·13	1·37	—	—	—	0·43

Analyses of halotrichite *g* from Bogota by Mill, *h* from Pasto by Boussingault, *i* from Adelaide in New South Wales by Herapath, *k* from Saldana by Boussingault, *l* from Königsberg in Hungary, in oblique crystals, by Jurasky:—

	g	*h*	*i*	*k*	*l*
Sulphuric acid	29·0	35·68	35·63	36·40	36·75
Alumina	15·0	14·98	17·09	16·00	14·30
Red oxide of iron . . .	1·2		protox. ir.		2·15
Oxide of copper . . .	—	—	0·04	—	—
Water	51·8	49·34	46·70	46·60	44·60
Earthy matter . . .	3·0	—	0·50	—	2·01

Is found in botryoidal, fibrous and compact masses, in quarries of alum shale at Freienwald in Brandenburg and near Saalfeld in Thuringia; in the coal mines of Potschappel and Burgk not far from Dresden; in the beds of brown coal at Kolosoruk near Bilin, and of Friesdorf near Bonn; at Saldanha and Socorro in Columbia, Chivachy near Bogota, Araya near Cumana, in the crater of the volcano of Pasto in Quito, Coquimbo in Chile, Pyromeni in Milo, the Solfatara of Naples.

376. WEBSTERITE.—Subsulphate of alumina; Phillips; Alumine sous-sulfatée; Hauy. Aluminit; Mohs, Hausmann, Haidinger.

Opaque. Dull. White. Streak white. Sectile. H = 1·0. G = 1·6...1·7.

In the matrass yields water which has an acid reaction. Infusible before the blowpipe. With solution of cobalt becomes blue. Easily soluble in hydrochloric acid.

$\dddot{\mathrm{Al}}\dddot{\mathrm{S}} + 9\dot{\mathrm{H}}$, sulphuric acid 23·2, alumina 29·8, water 47·0.

Analyses of websterite *a* from Halle, *b* from Morl near Halle, *c* from Newhaven, all by Stromeyer, from Halle *d* by Schmidt, *e* by Marchand, *f* from Lunel-Vieil by Dufrénoy:—

	a	*b*	*c*	*d*	*e*	*f*
Sulphuric acid . . .	23·37	23·68	23·37	23·25	22·3	23·45
Alumina	30·26	30·98	29·87	29·23	30·7	29·72
Lime	—	—	—	1·18	—	—
Water	46·37	45·34	46·76	46·34	47·0	46·80

Is found in reniform masses at Halle, Morl, Schlettau and Langenbogen near Halle, Auteuil near Paris, Lunel-Vieil in the department du Gard, Newhaven in Sussex. Combinations of $\bar{\mathrm{Al}}\dddot{\mathrm{S}} + 9\dot{\mathrm{H}}$ with hydrate of alumina in various proportions have been found in the neighbourhood of Halle.

377. GARNSDORFITE.—Pissophane; Dufrénoy. Pissophan; Hausmann, Haidinger.

Amorphous. Fracture conchoidal. Transparent...translucent. Lustre vitreous. Green, brown. Streak greyish-white, pale yellow. Brittle. H = 1·5...2·0. G = 1·922...1·981. Soluble in hydrochloric acid.

Analyses by Erdmann:—

Sulphuric acid	12·70	12·49	11·90
Alumina	35·15	35·30	6·80

Red oxide of iron . . .	9·74	9·80	40·06
Water	41·69	41·70	40·13
Gangue and loss	0·72	0·71	1·11

It is found in soft drops, which are gradually dried into horn-like masses, in the alum shale works at Garnsdorf near Saalfeld in Thuringia, and at Reichenbach in Saxony.

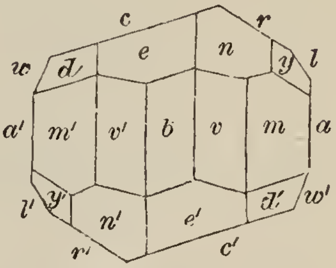
378. MIRABILITE.—Sulphate of soda; Phillips. Soude sulfatée; Hauy. Prismatisches Glauber-Salz; Mohs. Glaubersalz; Hausmann. Mirabilit; Haidinger.

Oblique. 101,100 = 57° 55′; 111,010 = 46° 36′; 101,001 = 49° 50′.

a 100, *b* 010, *c* 001, *e* 011, *r* 101, *l* 201, *w* $\bar{2}01$, *m* 110, *v* 120, *n* 111, *d* $\bar{1}11$, *y* 211.

bc	90°	0′	*mb*	40°	19′
ab	90	0	*mm′*	80	38
ca	107	45	*vv′*	45	59
lc	75	19	*yl*	30	54
la	32	26	*yy′*	118	12
rc	49	50	*nr*	43	24
ra	57	55	*nn′*	93	12
wc	47	56	*ee′*	86	31
wa′	24	19	*dd′*	110	42
ma	49	41			

FIG. 539.



Combinations. *amec*, *namecb*, *nmraecb*, *nmawecb*, *lrnyamvdwecb*. Twins. Twin-face *c*. Cleavage. *c*, very perfect and easily obtained; *a*, *b*, faint traces. Fracture conchoidal. Transparent. Lustre vitreous. R = 1·44. The optic axes lie in a plane perpendicular to the face *b*, making an angle of 12° 24′ with a normal to *a*, and an angle of 11° 55′ with a normal to *w′*. The optic axes make angles of 40° 13′ with a normal to *b*. Colourless, white. Streak white. Sectile. H = 1·5...2·0. G = 1·481. Taste cooling, bitter.

$\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}} + 10\dot{\mathrm{H}}$, sulphuric acid 24·85, soda 19·24, water 55·91.

Melts in the matrass. Before the blowpipe on charcoal melts and is converted into an alkaline hepar. Effloresces when exposed to dry air. At 0° C is soluble in 10 parts of water; at 33° C in 0·33 parts of water.

In crystals formed in the winter in salt springs; as an efflorescence on the soil, and on the shores of salt lakes; dissolved in mineral waters.

Is found at Aussee, Ischel and Hallstadt in Austria, Hallein near Salzburg, Eger in Bohemia, Hall in the Tyrol, in several places in Hungary and Spain, Hildesheim in the Harz, Mühling and Mönchenstein in Switzerland, Sulz in Wirtemberg; on lavas; as an efflorescence on the Siberian and Caspian steppes; in the mineral springs of Carlsbad, Sedlitz, Saidschütz and Püllna; in the salt lakes of Egypt.

Chromate of soda, $\dot{\mathrm{Na}}\bar{\mathrm{Cr}}+10\dot{\mathrm{H}}$, is isomorphous with mirabilite.

379. ASTRAKHANITE.—Astrachanit; Hausmann. Astrakanit; Haidinger.

Transparent. Colourless. Taste cooling and bitter. Efflorescent. Easily soluble in water.

$$\dot{\mathrm{Na}}\dddot{\mathrm{S}} + \dot{\mathrm{Mg}}\dddot{\mathrm{S}} + 4\dot{\mathrm{H}}.$$

Analysis by G. Rose:—

Sulphate of soda	41·00
Sulphate of magnesia	35·18
Chloride of magnesium . . .	0·33
Water	21·56
Gypsum mixed with sand . .	1·75

Is found in prismatic crystals below a crust of salt at the bottom of the salt lakes of Astrakhan.

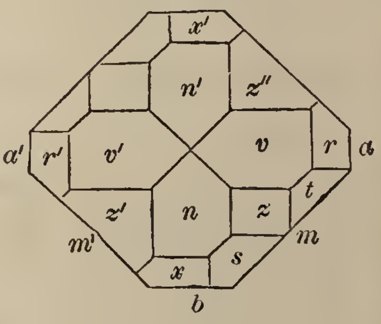
380. EPSOMITE.—Sulphate of magnesia; Phillips. Magnésie sulfatée; Hauy. Prismatisches Bitter-Salz; Mohs. Bittersalz; Hausmann. Epsomit; Haidinger.

Prismatic. 011,010=60° 2′; 101,001=29° 43′·5; 110,100=45° 17′.

a 100, *b* 010, *n* 011, *x* 021, *v* 101, *r* 201, *m* 110, *f* 210, *z* 111, *s* 121, *t* 211. *f* truncates the edge *ma*. The forms *z*, *s*, *t* are frequently hemihedral with inclined faces.

ab	90° 0′		*zz″*	53° 12′	
nn′	59	56	*z′z″*	78	7
xx′	97	35	*tt′*	89	42
vv′	59	27	*tt″*	61	56
rr′	98	8	*t′t″*	103	58
mm′	89	26	*ss′*	41	1
ff′	126	22	*ss″*	90	5
zz′	52	38	*s′s″*	104	18

FIG. 540.



Combinations. *mz*, *mz′*, *maz*, *nvzma*, *vzmfa*, *nvzxrs′t′*. Cleavage. *a*, very perfect; *v*, less perfect; *m*, traces. Fracture conchoidal. Transparent...translucent. Lustre vitreous. For light in a plane perpendicular to the faces *a*, *b*, and polarized in that plane $\mu = 1{\cdot}4817$. The optic axes are in a plane perpendicular to the faces *a*, *b*, and make angles of 25° 26′ with a normal to *b*. Colourless, white, pale red. Streak white. H = 2·0...2·5. G = 1·7...1·8. Taste bitter and saline.

In the matrass yields much water. Before the blowpipe melts at first, and is then changed into an alkaline, infusible mass, which, with solution of cobalt, becomes red. With soda yields a hepar. Is soluble in 3·9 parts of water at 0° C. Effloresces in dry air.

$\dot{Mg}\dddot{S} + 7\dot{H}$, sulphuric acid 32·36, magnesia 16·68, water 50·96.

Analyses of epsomite *a* from the Bosjesman's river in South Africa, *b* from Idria, *c* from Calatayud in Aragon, *d* from Neusohl in Hungary, all by Stromeyer, *e* from Fitou in France by Bouis, *f* from the Caucasus by Osersky:—

	a	*b*	*c*	*d*	*e*	*f*
Sulphuric acid . .	32·26	32·30	31·90	31·37	34·37	32·46
Magnesia	14·58	16·39	16·50	15·31	17·31	15·97
Soda	—	—	—	—	—	0·47
Protox. iron . . .	—	0·23	—	0·09	—	—
Oxide of mang. . .	3·62	—	—	0·34	—	—
Oxide of cobalt . .	—	—	—	0·69	—	—
Oxide of copper . .	—	—	—	0·38	—	—
Water	49·24	50·93	51·20	51·70	48·32	50·60

Is found as an efflorescence, or in capillary crystals, in Hungary, Idria, near Sedlitz and Saidschütz in Bohemia, in the salt mines of the Tyrol and Berchtesgaden, Calatayud in Aragon and in many other parts of Spain, in a cave on the Bosjesman's river in South Africa beneath a crust of pickeringite, in the Russian steppes, in the island of Milo, in the mineral springs of Seidschütz, Sedlitz, Püllna and Epsom. Epsomite may be obtained by evaporating a solution of sulphate of magnesia at a temperature below 15° C.

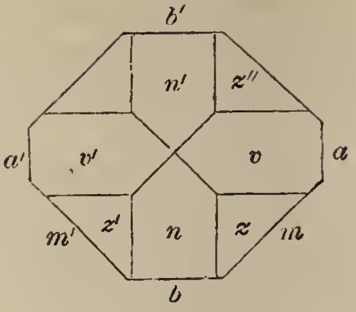
381. GOSLARITE.—Sulphate of zinc; Phillips. Zinc sulfaté; Hauy. Prismatisches Vitriol-Salz; Mohs. Zinkvitriol; Hausmann. Goslarit; Haidinger.

Prismatic. 011,010=60° 10′; 101,001=29°58′·5; 110,100=45°21′.

a 100, *b* 010, *n* 011, *v* 101, *m* 110, *f* 210, *z* 111, *t* 211.

ab	90°	0′	*mm′*	89°	18′
nb	60	10	*ff′*	126	35
nn′	59	40	*zz′*	52	33
vv′	59	57	*zz″*	53	15
ma	45	21	*z′z″*	78	5
mb	44	39			

FIG. 541.



Combinations. *mz*, *maz*, *vzma*, *mabznv*, *nvztmfa*. Cleavage. *a*, very perfect; *v*, less perfect; *m*, traces. Fracture conchoidal. Transparent...translucent. Lustre vitreous. R = 1·517. Colourless, white, pale red, blue. Streak white. Brittle. H = 2·0...2·5. G = 1·9...2·1. Taste astringent and metallic.

In the matrass yields water; when heated to redness with charcoal powder sulphurous acid is disengaged. Before the blowpipe on charcoal intumesces and leaves an infusible crust, which, with solution of cobalt, becomes green. Is soluble in 2·3 parts of cold water.

$\dot{Zn}\dddot{S} + 7\dot{H}$, sulphuric acid 27·87, oxide of zinc 28·24, water 43·89.

Analyses of goslarite *a* from Cornwall by Schaub, *b* from Schemnitz by Beudant, *c* from Goslar by Klaproth, *d* from Goslar by Hausmann:—

	a	*b*	*c*	*d*
Sulphuric acid	21·60	29·8	22·0	71·74
Water	46·50	40·8	50·0	
Oxide of zinc	25·66	28·5	27·5	21·74
Oxide of manganese	4·33	0·7	0·5	6·52
Oxide of copper	1·00	—	—	—
Oxide of iron	0·17	0·4	—	—
Quartz	0·67	—	—	—

It occurs principally in the deserted galleries of old mines, and is supposed to arise from the decomposition of blende, with which it is frequently associated.

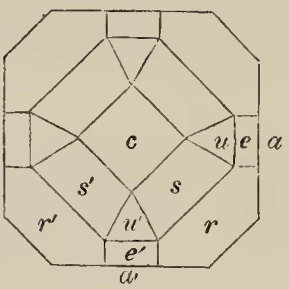
Is found in the Rammelsberg mine near Goslar, Holzappel in Nassau, Schemnitz, Miedzianagora, Fahlun, Holywell, Cornwall, France, Spain. Crystals of goslarite are obtained by evaporating a solution of sulphate of oxide of zinc at the ordinary temperature of the atmosphere.

A neutral solution of sulphate of oxide of nickel in water affords crystals of $\dot{Nk}\dddot{S} + 7\dot{H}$, which are isomorphous with epsomite and goslarite. In $\dot{Nk}\dddot{S} + 7\dot{H}$, *mm′* = 88° 50′, *zm* = 51° 2′. *nb* = 60° 0′, *va* = 60° 37′. Cleavage. *m*.

An acid solution of sulphate of oxide of nickel yields crystals of $\dot{\text{N}}\text{k}\dddot{\text{S}} + 7\dot{\text{H}}$ belonging to the pyramidal system, and isomorphous with $\dot{\text{N}}\text{k}\dddot{\text{S}}\text{e} + 7\dot{\text{H}}$, and $\dot{\text{Z}}\text{n}\dddot{\text{S}}\text{e} + 7\dot{\text{H}}$. The symbols of the forms in crystals of this isomorphous group are :—*a* 100, *c* 001, *e* 101, *u* 203, *r* 111, *s* 112. Cleavage. *c*, very perfect.

In $\dot{\text{N}}\text{k}\dddot{\text{S}}\text{e} + 7\dot{\text{H}}$, selenic acid 38·4, oxide of nickel 22·9, water 38·7, $aa' = 90° \, 0'$, $ac = 90° \, 0'$, $ee'' = 124° \, 11'$, $uu'' = 103° \, 3'$, $rc = 69° \, 28'$, $sc = 53° \, 10'$.

FIG. 542.



In $\dot{\text{N}}\text{k}\dddot{\text{S}} + 7\dot{\text{H}}$, sulphuric acid 28·5, oxide of nickel 26·7, water 44·8, $rc = 69° \, 39'$.

In $\dot{\text{Z}}\text{n}\dddot{\text{S}}\text{e} + 7\dot{\text{H}}$, selenic acid 38·1, oxide of zinc 24·1, water 37·8, $rc = 69° \, 26'{\cdot}5$.

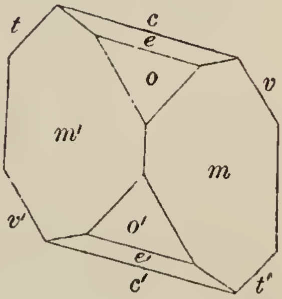
382. **BIEBERITE.**—Sulphate of cobalt; Phillips. Cobalt sulfaté; Dufrénoy. Kobalt vitriol; Mohs, Hausmann. Bieberit; Haidinger.

Oblique. 101,100 = 31° 0′; 111,010 = 50° 32′; 101,001 = 44° 6′.

c 001, *o* 011, *e* 012, *v* 101, *t* $\bar{1}$01, *m* 110.

oc	57°	5′	*tc*	63°	25′
oo′	65	50	*vt′*	72	29
ec	27	15	*mm′*	82	20
ee′	125	30	*mc*	80	15
vc	44	6			

FIG. 543.



Combinations. *mc*, *mcvtoe*. Fracture uneven. Translucent...opaque. Lustre vitreous. Flesh-red, rose-red. Streak reddish-white. Taste astringent.

When heated strongly before the blowpipe emits sulphurous acid. Imparts a blue colour to borax. Soluble in water.

$\dot{\text{C}}\text{o}\dddot{\text{S}} + 7\dot{\text{H}}$, sulphuric acid 28·77, oxide of cobalt 25·90, water 45·33.

Analyses of bieberite *a* from Bieber by Winkelblech, *b* from Muderbach near Siegen by Schnabel :—

	a	*b*
Sulphuric acid	29·05	28·81
Oxide of cobalt	19·91	23·30
Oxide of copper	—	0·30

	a	*b*
Lime	—	0·43
Magnesia	3·86	0·88
Chlorine	—	0·04
Water	46·83	45·22
Earthy matter	—	1·14

Is found in botryoidal and compact masses, in old mines at Bieber and Siegen, with various ores of cobalt.

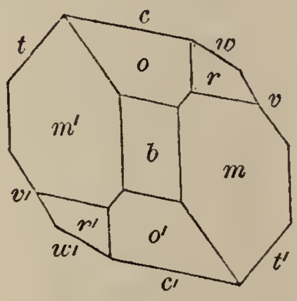
383. MELANTERITE.—Sulphate of iron; Phillips. Fer sulfaté; Hauy. Hemiprismatisches Vitriol-Salz; Mohs. Eisenvitriol; Hausmann. Melanterit; Haidinger.

Oblique. 101,100 = 31° 53′; 111,010 = 50° 46′; 101,001 = 43° 47′.

a 100, *b* 010, *c* 001, *o* 011, *e* 013, *v* 101, *w* 103, *t* $\bar{1}$01, *m* 110, *r* 111. *e* truncates the edge *oc*; *a* truncates the edge formed by *m* and the face parallel to *m′*.

bc	90°	0′	*ec*	26°	32′
ca	75	40	*ee′*	126	56
ab	90	0	*ob*	33	44
vc	43	47	*oc*	56	16
va	31	53	*oo′*	67	28
wc	20	54	*mm′*	82	21
wa	54	46	*rb*	50	46
tc	61	58	*rv*	39	14
ta′	42	22	*rr′*	101	32
eb	63	28	*mc*	80	37

FIG. 544.



Combinations. *cm*, *ctm*, *comb*, *ctomab*, *crotmb*, *cmvwteo*, *cwvrotmb*. Cleavage. *c*, very perfect; *m*, less perfect; *t*, faint traces. Fracture conchoidal. Transparent...translucent. Lustre vitreous. R = 1·494. The optic axes lie in a plane parallel to *b*, making with each other an angle of 81° 30′, and with a normal to *c* angles not very unequal. Green of various shades, white. Streak white. Rather brittle. H = 2·0. G = 1·8...1·9. Taste very astringent.

Before the blowpipe emits sulphurous acid and becomes red. The residue, on charcoal in the inner flame, becomes black and magnetic, and imparts a green colour to glass of borax. Soluble in 1·43 parts of water at 15° C, and in 0·3 parts at 100° C.

$\dot{\mathrm{Fe}}\dddot{\mathrm{S}} + 7\dot{\mathrm{H}}$, sulphuric acid 28·47, protoxide of iron 26·68, water 44·85.

In crystals, botryoidal, reniform, pseudomorphous after pyrite. It is produced by the decomposition of sulphides of iron.

Is found in the mines near Goslar, Fahlun, Herrengrund, Schemnitz, Kremnitz, Schmölnitz, Häring and Stèrzing.

$\dot{\mathrm{Fe}}\dddot{\mathrm{S}} + 7\dot{\mathrm{H}}$ and $\dot{\mathrm{Co}}\dddot{\mathrm{S}} + 7\dot{\mathrm{H}}$ are isomorphous with crystals of $\dot{\mathrm{Mn}}\dddot{\mathrm{S}} + 7\dot{\mathrm{H}}$ obtained from a solution of sulphate of protoxide of manganese below 6° c. A mixture of nearly equal parts of sulphate of protoxide of iron and sulphate of oxide of copper, or of sulphate of oxide of nickel and sulphate of oxide of copper, crystallizes with seven proportionals of water, in forms isomorphous with melanterite.

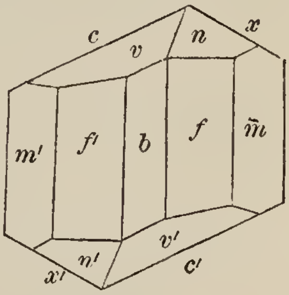
384. BOTRYOGEN.—Fer sulfaté rouge; Dufrénoy. Hemiprismatisches Botryogen-Salz; Mohs. Botryogen; Hausmann, Haidinger.

Oblique. 101,100 = 63° 5′; 111,010 = 62° 41′; 101,001 = 54° 29′.

b 010, *c* 001, *v* 023, *x* 101, *m* 110, *f* 120, *n* 111.

bc	90°	0′	*ff′*	81°	44′
xb	90	0	*nb*	62	41
vb	70	30	*nx*	27	19
vc	19	30	*nn′*	125	22
vv′	141	0	*mc*	113	37
xc	54	29	*cm′*	66	23
mb	59	58	*nc*	58	56
mm′	119	56	*mbc*	117	34
fb	40	52			

FIG. 545.



Combinations. *cvmf*, *cvnxmfb*. Cleavage. *m*, tolerably perfect; *f*, traces. Fracture conchoidal. Translucent. Lustre vitreous. Hyacinth-red...ochre-yellow. Streak ochre-yellow. Sectile. H = 2·0...2·5. G = 2·039. Taste slightly astringent.

In the matrass yields water. Before the blowpipe becomes red in the outer flame, and black in the inner flame. Imparts the colour of iron to fluxes. Partially soluble in boiling water, leaving a yellow residue.

Analyses by Berzelius:—

Sulphate of protoxide of iron . .	6·77	6·85	48·3
Sulphate of oxide of iron $(\dot{\mathrm{F}}\,\dddot{\bar{\mathrm{F}}}\,\dddot{\mathrm{S}})$.	35·85	39·92	
Sulphate of magnesia	26·88	17·10	20·8
Sulphate of lime	2·22	6·71	—
Water and loss	28·28	31·42	30·9

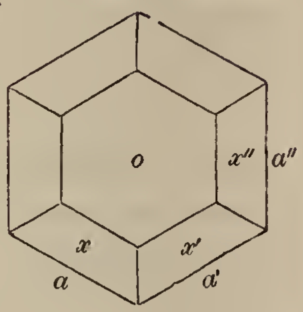
In crystals and massive. It appears to be a product of the decomposition of pyrite, along with which it is found at Fahlun in Sweden. It is said to have been found also on Vesuvius.

385. COQUIMBITE.—Coquimbit; Dufrénoy, Hausmann, Haidinger.

Rhombohedral. 100,111 = 43° 50′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *x* 120.

FIG. 546.



ao	90°	0′
ba′	30	0
bb″	60	0
aa′	60	0
xo	29	0
xx′	51	52

Cleavage. *a*, *x*, imperfect. Fracture conchoidal...uneven. Translucent. White passing into blue and green. H = 2·0...2·5. G = 2·0...2·1. Taste vitriolic.

In the matrass yields water and sulphurous acid. Is perfectly soluble in cold water. On heating the solution red oxide of iron is precipitated.

$\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{S}}^3 + 9\dot{\bar{\mathrm{H}}}$, sulphuric acid 43·0, red oxide of iron 28·0, water 29·0.

Analyses by H. Rose:—

Sulphuric acid	43·55	43·55
Red oxide of iron	24·11	25·21
Alumina	0·92	0·78
Lime	0·73	0·14
Magnesia	0·32	0·21
Silica	0·31	0·37
Water	30·10	29·98

Is found in crystals and massive, in a thick bed in green felspar, in the district of Copiapo in Coquimbo.

Blakeite (Dana) is the same substance in octahedrons, and capable of recrystallizing in octahedrons. Analysis by Blake:—sulphuric acid 41·37, red oxide of iron 26·79, magnesia 0·30, silica 0·82, water 29·40.

386. COPIAPITE.—Copiapit; Hausmann, Haidinger.

In short six-sided prisms. Cleavage parallel to the base, perfect. Translucent. Lustre pearly. Yellow.

Analyses by H. Rose:—

Sulphuric acid	39·60	not det.
Red oxide of iron	26·11	24·56
Alumina	1·95	0·26
Lime	—	0·12
Magnesia	2·64	3·34
Silica	1·37	2·62
Water	29·67	29·30

Is found incrusting coquimbite in the district of Copiapo in the province of Coquimbo in Chile.

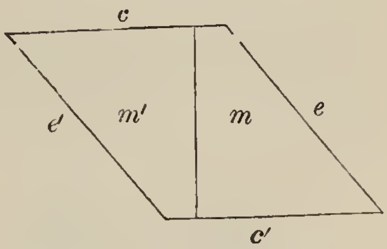
387. JOHANNITE.—Urane sous-sulfaté; Dufrénoy. Hemiprismatisches Euchlor-Salz; Mohs. Johannit; Hausmann, Haidinger.

Oblique. 101,100 = 34° 1′; 111,010 = 41° 13′; 101,001 = 51° 28′.

b 010 cleavage, *c* 001, *e* 101, *m* 110, *u*, *v* are faces truncating the edges *ec*, *ec′*.

bc	90°	0′	*mm′*	69°	0′
eb	90	0	*mc*	87	28
ec	51	28	*me*	62	0
mb	34	30			

FIG. 547.



Combinations. *cem*, *cemuv*. Cleavage. *m*, *b*, traces. Fracture imperfect conchoidal. Semi-transparent. Lustre vitreous. Grass-green. Streak siskin-green. Sectile. H = 2·0...2·5. G = 3·191. Taste slightly bitter.

In the matrass yields water and becomes brown. Before the blowpipe with borax forms a green glass. With soda in the inner flame yields a bead of copper. Partially soluble in water. Soluble in hydrochloric acid.

Consists of sulphate of oxide of copper, sulphate of oxide of uranium, and water, in unknown proportions.

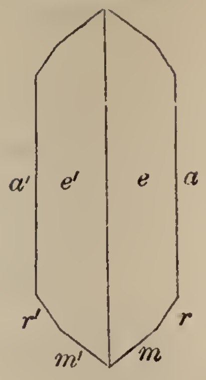
Is found in crystals and reniform masses at Joachimsthal and Johann-Georgenstadt in Bohemia.

388. BROCHANTITE.—Prismatischer Dystom-Malachit; Mohs. Brochantit; Hausmann, Haidinger.

Prismatic. 011,010 = 72° 10′; 101,001 = 14° 4′; 110,100 = 52° 5′.

a 100, *v* 021, *e* 101, *m* 110, *r* 210. *v* truncates the solid angle *ee′mm′*.

FIG. 548.



vv'	65°	31'	*ma*	52°	5'
ea	75	56	*rr'*	114	36
ee'	28	8	*mm'*	75	50
ra	32	42	*va*	90	0

Combinations. *aemr*, *aerv*. The faces *a*, *r*, *m* striated parallel to their intersections with each other; *e*, *v* curved. Cleavage. *a*, very perfect; *m*, traces. Fracture conchoidal, scarcely observable. Transparent...translucent. Lustre vitreous. Emerald-green...blackish-green. Streak green. H = 3·5 ...4·0. G = 3·87...3·9069.

In the matrass yields water and sulphurous acid. Before the blowpipe on charcoal, in a strong heat, melts and is suddenly reduced to a globule of malleable copper covered with a black crust. Imparts the colour of copper to the fluxes. Soluble in acids, but not in water.

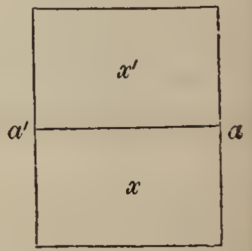
$\dot{\mathrm{C}}\mathrm{u}\dddot{\mathrm{S}} + 3\dot{\mathrm{C}}\mathrm{u}\dot{\mathrm{H}}$, sulphuric acid 17·7, oxide of copper 70·3, water 12·0.

Analyses of brochantite *a*, *b* from Rezbanya by Magnus, *c* from Iceland (krisuvigite) by Forchammer:—

	a	*b*	*c*
Sulphuric acid	17·13	17·43	18·88
Oxide of copper	62·63	66·94	67·75
Oxide of tin	8·18	3·14	—
Oxide of lead	0·03	1·05	—
Water	11·89	11·92	12·81

Is found in crystals, reniform and compact masses, in the Gumschewsk mine near Katharinenburg in Siberia, Rezbanya in Hungary, Saintbel near Lyons in France, Krisuvig in Iceland.

FIG. 549.



Levy's königine, from Werchoturi in Siberia, is probably brochantite. Prismatic. *xa* = 90° 0', *xx'* = 105° 0'. The faces *a* striated parallel to a line bisecting the angle between *x* and *x'*; *x*, very uneven. Cleavage. *a*. The faces *x* would be those of a form 041 in brochantite. Translucent. Emerald-green... blackish-green. Consists of sulphuric acid, oxide of copper and water.

389. LINARITE.—Cupreous sulphate of lead; Phillips.

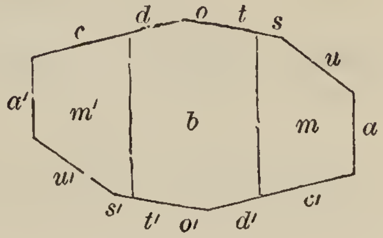
Sulfate de plomb cuivreux; Beudant. Diplogener Lasur-Malachit; Mohs. Bleilasur; Hausmann. Linarit; Haidinger.

Oblique. 101,100 = 74° 25′; 111,010 = 50° 26′; 101,001 = 28° 20′.

a 100, *b* 010, *c* 001, *d* 108, *o* 203, *t* 506, *u* 201, *m* 110.

ab	90°	0′	*ta*	78°	59′
ob	90	0	*sa*	74	25
ca	102	45	*ua*	51	54
da	99	16	*ma*	59	30
oa	83	42	*mm′*	61	0

FIG. 550.



Combinations. *ocsmab*, *odtcsumab*. Twins. Twin-face *a*. Cleavage. *a*, very perfect; *c*, less perfect. Fracture conchoidal. Feebly translucent. Lustre adamantine. Deep azure-blue. Streak pale blue. Slightly brittle. H = 2·5...3·0. G = 5·30...5·43.

Before the blowpipe affords the reactions of lead and copper.

$\dot{\mathrm{Pb}}\dddot{\mathrm{S}} + \dot{\mathrm{Cu}}\dot{\mathrm{H}}$, sulphate of oxide of lead 75·74, oxide of copper 19·78, water 4·48.

Analyses of linarite from Leadhills *a* by Brooke, *b* by Thomson:—

	a	*b*
Sulphate of oxide of lead . .	75·4	74·8
Oxide of copper	18·0	19·7
Water	4·7	5·5

Is found in crystals and massive, at Leadhills in Scotland, Linares in Spain, and in Cumberland.

390. LETTSOMITE.—Velvet copper ore. Cuivre velouté; Dufrénoy. Kupfersammterz; Haidinger.

In short capillary crystals. Translucent. Lustre pearly. Smalt blue.

$2\dddot{\mathrm{S}} + 6\dot{\mathrm{Cu}} + \dddot{\mathrm{Al}} + 12\dot{\mathrm{H}}$, sulphuric acid 16·78, oxide of copper 49·85, alumina 10·76, water 22·59.

Analyses of a very small quantity by Dr. Percy:—

Sulphuric acid	15·38	14·12
Oxide of copper	48·16	46·59

Alumina	11·70	11·06
Red oxide of iron		1·18
Water	23·06	23·06
Insoluble in dilute $\bar{N}$		2·35

Is found with malachite and chessylite coating the cavities of a hydrous iron oxide at Moldawa in the Banat.

391. BLUE VITRIOL.—Sulphate of copper; Phillips. Cuivre sulfaté; Hauy. Tetartoprismatisches Vitriol-Salz; Mohs. Kupfervitriol; Hausmann. Vitriol; Haidinger.

Anorthic. $\bar{1}10,010$ = 31° 13′·3; $\bar{1}10,\bar{1}00$ = 69° 27′·5; 011,010 = 59° 9′·6; 011,001 = 50° 28′·5; 001,$\bar{1}00$ = 65° 3′·7.

r 100, *n* 010, *k* 001, *p* 011, *w* 301, *q* 201, *o* 101, *v* $\bar{1}01$, *m* 110, *t* $\bar{1}10$, *d* $\bar{1}20$, *h* $\bar{2}10$, *z* 311, *s* $\bar{1}11$, *x* $\bar{2}11$.

pn	59°	10′	*ok*	29°	42′	*pz*	62°	40′
kp	50	28	*mr*	53	3	*sp*	21	45
kn′	70	22	*mn*	26	16	*xp*	35	4
wr	40	16	*nt*	31	13	*oz*	62	35
qr	57	40	*tr′*	69	28	*pt*	52	19
or	85	14	*dm*	42	15	*pr′*	76	33
kr	114	56	*hm*	80	6	*op*	55	5
vr	135	23	*zm*	40	39	*vp*	54	22
vk	20	27	*zr*	40	47	*km′*	62	25
						wn′	87	34
						wn	92	26
						on′	74	27
						vn′	70	38
						wz	33	20
						zn	59	6
						pw	78	6
						mp	71	48
						vm′	53	50

FIG. 551.

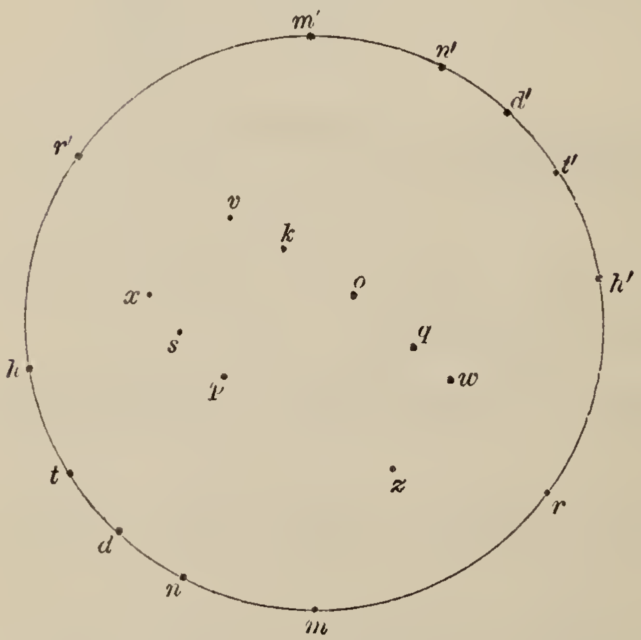
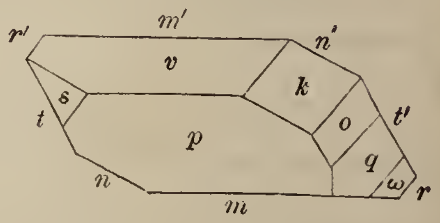


FIG. 552.



Combinations. *ptmn.s.v*, *opmrn*, *pwztmrn.s.o.q.k.v*, *pvtmrn.o.oqk*, *ptmrn..z.w.q.o.k.v.s.x*. The faces *r*, *t*, *m* striated parallel to their intersections with each other. Cleavage. *m*, imperfect; *t*, very imperfect. Fracture conchoidal. Semi-transparent...translucent. Lustre vitreous. Blue. Streak white. Rather brittle. H = 2·5. G = 2·19...2·30. Taste astringent and metallic.

Before the blowpipe imparts a green colour to the flame, melts and is reduced to metallic copper. Soluble in water. The solution deposits metallic copper on bright iron.

$\dot{\mathrm{Cu}}\dddot{\mathrm{S}} + 5\dot{\mathrm{H}}$, sulphuric acid 32·08, oxide of copper 31·83, water 36·09.

It owes its existence principally to the decomposition of sulphides of copper, and occurs dissolved in water issuing from mines. It is found in the Rammelsberg mine near Goslar, Fahlun, Neusohl in Hungary, Anglesea, Cornwall, Wicklow, Rio Tinto near Seville, Tamassus and Chrusocco in Cyprus, Turinsk and Nischne-Tagilsk in Siberia.

Blue vitriol is isomorphous with sulphate of protoxide of manganese crystallized at a temperature between 7° C and 20° C, $\dot{\mathrm{Mn}}\dddot{\mathrm{S}} + 5\dot{\mathrm{H}}$, and with seleniate of oxide of copper, $\dot{\mathrm{Cu}}\dddot{\mathrm{Se}} + 5\dot{\mathrm{H}}$.

CHROMATES.

392. LEHMANNITE.

—Chromate of lead; Phillips. Plomb chromaté; Hauy. Hemiprismatischer Blei-Baryt; Mohs. Kallochrom; Hausmann. Krokoit; Haidinger.

Oblique. 101,100 = 39° 2′; 111,010 = 59° 29′; 101,001 = 38° 59′.

a 100, *b* 010, *c* 001, *y* 021, *z* 011, *w* 012, *h* 101, *k* $\bar{1}01$, *e* 201, *x* $\bar{3}01$, *n* 401, *l* $\bar{4}01$, *d* 210, *g* 320, *m* 110, *f* 120, *t* 111, *v* $\bar{1}11$, *s* 441, *u* $\bar{2}11$.

na	13°	6′	*db*	64°	54′	*sn*	40°	56′
ea	23	55	*gb*	58	1	*sb*	49	4
ha	39	2	*mb*	46	52	*ub*	65	49
ca	78	1	*fb*	28	5	*ta*	47	59
la′	14	29	*dd′*	129	48	*za*	81	11
xa′	19	19	*gg′*	116	2	*va*	120	35
ka′	51	2	*mm′*	93	44	*ua*	143	12
cb	90	0	*ff′*	56	10	*tc*	48	15
wb	65	24	*th*	30	31	*sc*	71	19
zb	47	31	*tb*	59	29	*mc*	81	17
yb	28	38	*vk*	36	3	*vc*	59	38
ab	90	0	*vb*	53	57			

FIG. 553.

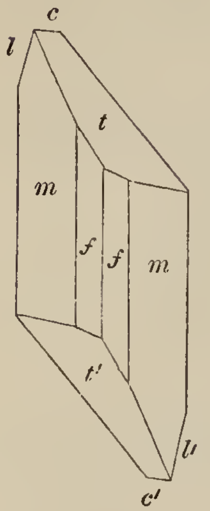


FIG. 554.

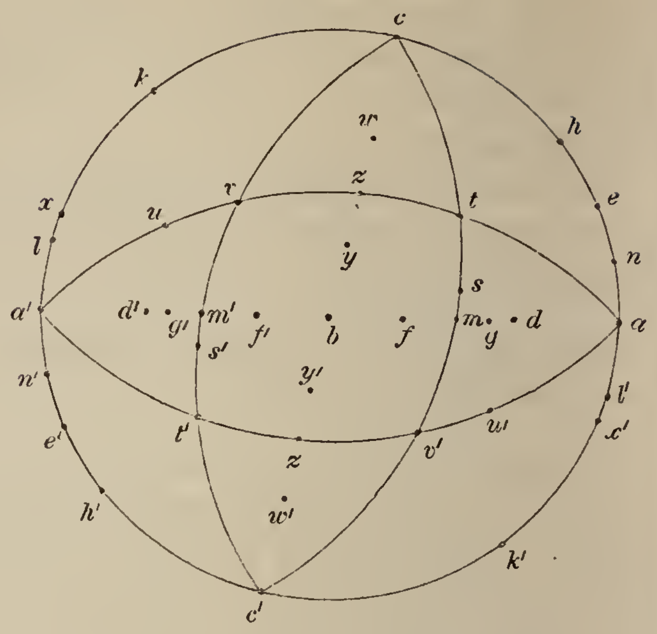
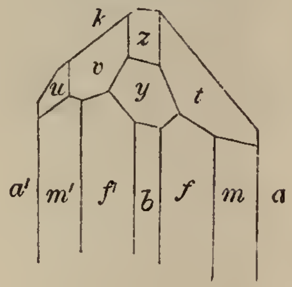


FIG. 555.



Combinations. *bx*, *ml..n.f*, *mt.l.u.s.a*, *mtc..v.z.y.b*, *tkmf..n.b.d*, *ntvmdb*, *tzykvumfba*, *mtf..x.e.c.d.s*, *mtfxb..c.a.s*, *mtxfck..v.d.z.s*, *mtxf.sak.yz*, *mtxfyzsakvu*, *mtxfcdglyzw*. The faces *a*, *b*, *m*, *f*, *g*, *d* striated parallel to their intersections with each other; *l*, usually curved. Cleavage. *m*, tolerably distinct; *a*, *c*, less distinct. All imperfect. Fracture small conchoidal, uneven. Translucent...translucent on the edges. Lustre adamantine. R = 2·974, 2·500. Hyacinth-red of various shades. Streak orange. Sectile. H = 2·5...3·0. G = 5·9...6·1.

Decrepitates when heated. Before the blowpipe on charcoal grows darker and melts, a portion of the lead being reduced. With borax or salt of phosphorus fuses easily in the outer flame into a green glass, and in the inner flame into a grey glass. With soda the lead is easily reduced. Is decomposed by warm hydrochloric acid, leaving a crystalline powder of chloride of lead. The solution is green. Nitric acid affords, with difficulty, a reddish-yellow solution. In potash becomes brown and dissolves, forming a yellow solution.

$\dot{\mathrm{Pb}}\dddot{\mathrm{Cr}}$, chromic acid 32·50, oxide of lead 67·50.

Analyses by Pfaff and Berzelius:—

Chromic acid	31·72	31·50
Oxide of lead	67·91	68·50

Is found in crystals, massive and disseminated, in veins of quartz in granite, in the gold mines of Beresowsk in Siberia; in the Ural, in veins of quartz in granite, at Totschilnaja Gora near Mursinsk, and at Bertewaja Gora near Nischne-Tagilsk; with quartz in a vein in talcose slate at Congonhas do Campo in the province of Minas Geraes in the Brazils.

393. PHŒNICITE.—Melanochroite; Dufrénoy. Melanochroit; Mohs. Phönikochroit; Hausmann. Phönicit; Haidinger.

Cleavage in one direction perfect. Translucent on the edges. Lustre resinous, adamantine on the cleavage. Red. Streak brick-red. Slightly brittle. H = 3·0...3·5. G = 5·75.

Before the blowpipe on charcoal melts into a dark mass which crystallizes on cooling. In the inner flame the lead is reduced. Imparts a green colour to borax and salt of phosphorus. Partially soluble in hydrochloric acid, leaving a residue of chloride of lead. After prolonged exposure to heat the solution becomes green.

$\dot{\mathrm{P}}\mathrm{b}^3\dddot{\mathrm{C}}\mathrm{r}^2$, chromic acid 23·70, oxide of lead 76·30.

Analysis by Hermann:—

Chromic acid	23·31
Oxide of lead	76·69

Is found in small, nearly right-angled, tabular crystals and massive, in veins of quartz with galena and lehmannite, at Beresowsk in the Ural.

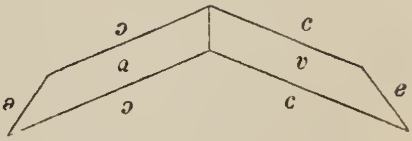
394. VAUQUELINITE.—Vauquelinite; Phillips, Beudant. Hemiprismatischer Melanochlor-Malachit; Mohs. Vauquelinit; Hausmann, Haidinger.

Oblique.

c 001, *a* 100 twin-face, *e* 101, *v* 111.

ec	31°	0′
ea	36	15

FIG. 556.



Combinations. *cv*, *cve*. Twins. Twin-face *a*. *cɔ* = 45° 30′. The faces *c* smooth and bright; the other faces slightly curved. Cleavage not observable. Fracture flat conchoidal...uneven. Slightly translucent...opaque. Lustre on surfaces of fracture waxy; on the faces of the crystals adamantine. Siskin-green, olive-green, blackish-green, brown. Streak siskin-green, frequently inclining to brown. H = 2·5...3·0. G = 5·5...5·8.

Before the blowpipe on charcoal intumesces and melts into a dark grey metallic bead, surrounded by globules of reduced lead. With borax and salt of phosphorus in the outer flame forms a green glass; in the inner flame, especially after adding tin, a red glass. With soda on platinum wire forms a glass which is green while hot, and yellow when cold, and colours water yellow with chromate of soda. Is soluble in nitric acid, forming a green solution, and leaving a yellow residue.

$\dot{Cu}^3\dddot{Cr}^2 + 2\dot{Pb}^3\dddot{Cr}^2$, oxide of lead 60·8, oxide of copper 10·8, chromic acid 28·4.

Analysis by Berzelius:—

Chromic acid	28·33
Oxide of lead	60·87
Oxide of copper	10·80

Is found in twin crystals, botryoidal and compact masses, with lehmannite, in veins of quartz, at Beresowsk in the Ural, Congonhas do Campo in the Brazils, Pontgibaud in Auvergne, North America.

VANADIATES.

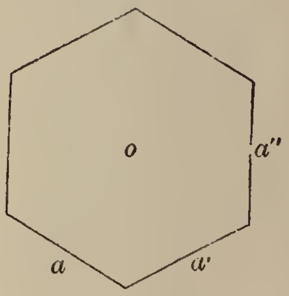
395. VANADINITE.—Plomb vanadiaté; Dufrénoy. Vanadinbleierz; Mohs. Vanadinit; Hausmann, Haidinger.

Rhombohedral.

o 111, *a* 01̄1.

ao	90°	0′
aa′	60	0

FIG. 557.



Combination. *oa*. Fracture conchoidal. Feebly translucent...opaque. Lustre vitreous. Yellow, brown, green, white. Streak white...yellow. H = 3·0. G = 6·83...6·89.

Decrepitates when heated. Before the blowpipe on charcoal melts into a globule and is reduced to metallic lead, depositing a yellow sublimate on the charcoal. With salt of phosphorus in the outer flame forms a glass which is of a reddish-yellow colour while hot, and of a yellowish-green colour when cold; in the inner flame forms a chrome-green glass. Dissolves in nitric acid, forming a green solution. With hydrochloric acid forms a green solution, leaving a residue of chloride of lead.

$PbCl + 2\dot{Pb} + \dot{Pb}^3\dddot{V}^3$.

Analysis of vanadinite from Zimapan by Berzelius:—

Basic vanadiate of oxide of lead . .	74·00
Basic chloride of lead	25·33
Hydrate of oxide of iron	0·67

In vanadinite from Zimapan, Del Rio found oxide of lead 80·72, a metallic (vanadic) acid 14·8.

Is found in globular aggregations at Zimapan in Mexico, in crystals with pyromorphite at Beresowsk in the Ural, Wanlockhead in Dumfriesshire.

396. DECHENITE.

Lustre greasy. Dull red...yellowish-red. Streak yellowish. H = 4·0. G = 5·81.

Alone before the blowpipe fuses into a yellowish glass. On charcoal fuses into a yellowish-green bead containing some grains of lead. With borax and salt of phosphorus gives the reaction of vanadic acid. With soda forms a white enamel containing grains of lead.

$\dot{Pb}\dddot{V}$, vanadic acid 45·33, oxide of lead 54·67.

Analyses by C. Bergemann:—

Vanadic acid	52·92	53·72	50·57
Oxide of lead	47·16	46·10	49·27

Is found in small botryoidal masses, with galena, cerussite and pyromorphite, near Nieder Schlettenbach in the Lauterthal in Rhenish Bavaria.

SULPHATES WITH CARBONATES.

397. CALEDONITE.

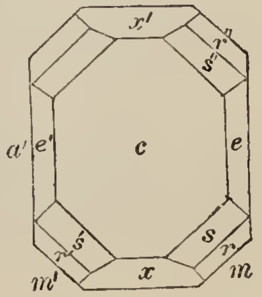
—Cupreous sulphato-carbonate of lead; Phillips. Calédonite; Beudant. Paratomer Blei-Baryt; Mohs. Caledonit; Hausmann, Haidinger.

Prismatic. 011,010=33° 9′; 101,001=54° 31′·5; 110,100=47° 30′.

a 100, *c* 001, *x* 021, *e* 101, *m* 110, *r* 111, *s* 223.

ca	90° 0′		*rr′*	75° 0′	
mc	90 0		*rr″*	83 15	
ee′	109 3		*r′r″*	128 35	
xx′	143 50		*ss′*	66 25	
ma	47 30		*ss″*	73 26	
mm′	85 0		*s′s″*	108 20	

FIG. 558.



Cleavage. *m*, *c*, *a*, imperfect. Fracture uneven. Transparent…translucent. Lustre resinous. Blue, greenish-blue. Streak blueish or greenish-white. Rather brittle. H = 2·5…3·0. G = 6·4.

Before the blowpipe on charcoal is reduced. Partially soluble with a slight effervescence in nitric acid, leaving a residue of sulphate of oxide of lead.

Analysis by Brooke:—

Sulphate of oxide of lead	55·8
Carbonate of oxide of lead	32·8
Carbonate of oxide of copper . . .	11·4

Is found in attached crystals, with other compounds of sulphate and carbonate of oxide of lead, at Leadhills in Scotland.

398. LANARKITE.—Sulphato-carbonate of lead; Phillips. Lanarkite; Beudant. Prismatoidischer Blei-Baryt; Mohs. Lanarkit; Hausmann, Haidinger.

Cleavage. *a*, very perfect; *u*, *v*, less perfect. *a*, *u*, *v* are in one zone:—

va	59° 15′
ua	88 45
vu	29 30

Transparent. Lustre adamantine, inclining to resinous and, on the perfect cleavage, to pearly. Greenish or yellowish-white. Streak white. Sectile. In thin plates flexible. H = 2·0…2·5. G = 6·8…7·0.

Before the blowpipe on charcoal is easily reduced. Partially soluble in nitric acid, with effervescence, leaving a residue of sulphate of oxide of lead.

$\dot{\mathrm{Pb}}\dddot{\mathrm{S}} + \dot{\mathrm{Pb}}\ddot{\mathrm{C}}$, sulphate of oxide of lead 53·16, carbonate of oxide of lead 46·84.

Analyses *a* by Brooke, *b* by Thomson:—

	a	*b*
Sulphate of oxide of lead . .	53·1	53·96
Carbonate of oxide of lead . .	46·9	46·04

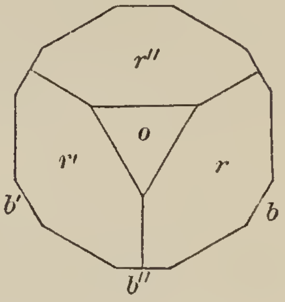
Has been found in long, slender crystals, either single or forming fibrous aggregations, at Leadhills in Scotland.

399. SUSANNITE.—Suzannit; Haidinger.

Rhombohedral. 100,111 = 68° 38′.

o 111, *b* $2\bar{1}\bar{1}$, *r* 100, *z* $\bar{1}22$, *s* $\bar{1}11$, *v* $5\bar{2}\bar{2}$. The faces *z*, *s* truncate the edge formed by *o* and the face parallel to *b*; *v* truncates the edge *rb*.

FIG. 559.



bo	90° 0′		*vo*	86° 48′	
bb″	60 0		*zo*	68 38	
bb′	120 0		*so*	78 56	
ro	68 38		*rr′*	107 30	

Cleavage. *o*, distinct and easily obtained. Transparent...translucent. Lustre resinous...adamantine. White, green, yellow, brownish-black. Streak white. H = 2·5. G = 6·55. Chemical characters the same as those of leadhillite.

$\dot{\mathrm{Pb}}\dddot{\mathrm{S}} + 3\dot{\mathrm{Pb}}\ddot{\mathrm{C}}$, sulphate of oxide of lead 27·44, carbonate of oxide of lead 72·56.

Analysis by Brooke:—

Sulphate of oxide of lead	27·5
Carbonate of oxide of lead	72·5

Is found in attached crystals at Leadhills in Scotland, and Moldawa in the Banat.

The substance $\dot{\mathrm{Pb}}\dddot{\mathrm{S}} + 3\dot{\mathrm{Pb}}\ddot{\mathrm{C}}$ is dimorphous, being prismatic in leadhillite and rhombohedral in susannite.

400. LEADHILLITE.—Sulphato-tricarbonate of lead; Phillips. Leadhillite; Beudant. Axotomer Blei-Baryt; Mohs. Leadhillit; Hausmann, Haidinger.

Prismatic. 011,010=24° 25′·4; 101,001=51° 37′·5; 110,100=60° 10′.

a 100, *c* 001, *l* 014, *w* 012, *n* 034, *i* 102, *f* 101, *e* 201, *m* 110, *k* 310, *d* 410, *x* 111, *v* 112, *z* 212, *s* 414, *o* 214. The forms *e*, *f*, *i*, and perhaps *o*, *s*, *z*, are frequently hemihedral with parallel faces.

lc	28° 50′	*ma*	60° 10′	*zc*	59° 10′
wc	47 45	*xa*	62 26	*sa*	42 6
nc	74 24	*xf*	53 49	*sf*	18 52
ic	32 16	*xc*	68 30	*sc*	54 2
fc	51 38	*va*	67 0	*oa*	24 19
ec	68 24	*vi*	42 57	*oe*	11 27
ac	90 0	*vc*	51 46	*oc*	68 51
da	23 33	*za*	49 40	*mm′*	59 40
ka	30 10	*zf*	34 21		

FIG. 560.

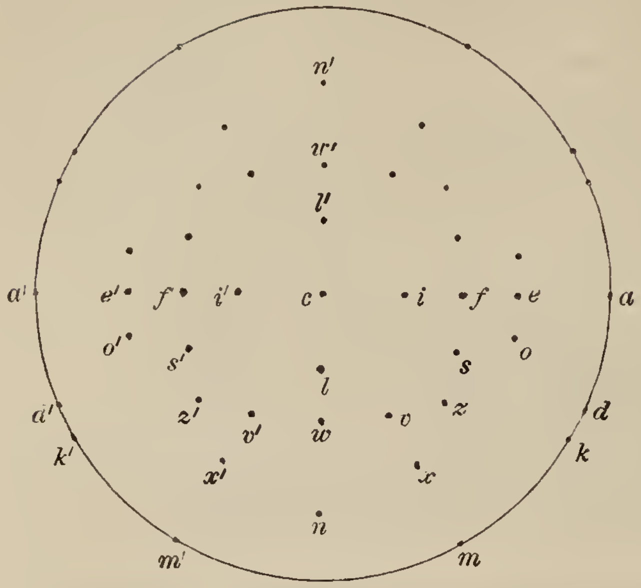


FIG. 561.

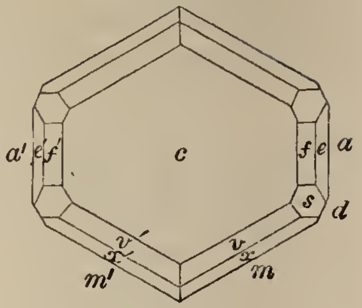
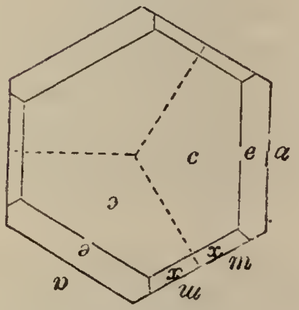


FIG. 562.



Combinations. *cex*, *cexma*, *cifevszxolwnmda.* Twins. 1. Twin-face *k ?*, *m ?* 2. Twin-face *f.* Cleavage. *c*, very perfect; *m*, *a*, traces. Fracture conchoidal. Transparent...translucent. Lustre resinous...adamantine. Yellowish-white, grey, green, yellow, brown. Streak white. Rather brittle. H = 2·5. G = 6·266...6·435.

Before the blowpipe intumesces and becomes yellow, but becomes white on cooling. On charcoal is completely reduced. Partially soluble with effervescence, in nitric acid, leaving a residue of sulphate of oxide of lead.

$\dot{\mathrm{Pb}}\dddot{\mathrm{S}} + 3\dot{\mathrm{Pb}}\ddot{\mathrm{C}}$, sulphate of oxide of lead 27·44, carbonate of oxide of lead 72·56.

Analyses *a* by Irving, *b* by Berzelius, *c* by Stromeyer, *d* by Thomson:—

	a	*b*	*c*	*d*
Sulphate of oxide of lead	29·0	28·7	27·3	27·43
Carbonate of oxide of lead	68·0	71·0	72·7	72·57

Is found in attached crystals at Leadhills in Scotland with other ores of lead. It is said to occur also in Spain, and in the island of Serpho.

Two mistakes have been committed in former descriptions of the crystals of leadhillite. One by Mr. Brooke, in regarding susannite and leadhillite as having the same rhombohedral form and angles, an error into which he was led by the very near agreement of the angles *ro* of susannite and *ec* of leadhillite, and by the occurrence of *e* alternately on the opposite sides of most of the twin-crystals of leadhillite; the alternation of the faces *e* being due to the hemihedral character of the form to which they belong. Mr. Haidinger was also deceived by the hemihedral form of these crystals; and, not having sufficiently perfect ones for measurement, was led to suppose the form of leadhillite to be oblique, and to be the only form belonging to this chemical compound. The opportunity, however, which we have had lately of measuring some very perfect crystals of leadhillite has removed all doubt of their being prismatic.

CARBONATES.

401. CERUSSITE.—Carbonate of lead; Phillips. Plomb carbonaté; Hauy. Diprismatischer Blei-Baryt; Mohs. Bleispath; Hausmann. Cerussit; Haidinger.

Prismatic. 011,010=40° 9′·5; 101,001=35° 52′; 110,100=58° 36′·5.

a 100, *b* 010, *c* 001, *y* 012, *d* 013, *x* 102, *k* 101, *i* 201, *v* 301, *z* 401, *f* 350, *m* 110, *r* 310, *p* 111, *o* 112, *g* 113, *s* 211, *w* 121.

bc	90°	0′	*ff′*	40°	49′	*ss″*	67°	58′
ca	90	0	*mm′*	62	47	*s′s″*	123	44
ab	90	0	*rr′*	122	43	*ww′*	42	12
yy′	61	18	*pp′*	50	0	*ww″*	125	0
dd′	43	6	*pp″*	87	41	*w′w″*	148	36
xx′	39	45	*p′p″*	108	28	*gg′*	25	16
kk′	71	44	*oo′*	34	33	*gg″*	42	1
ii′	110	40	*oo″*	58	15	*g′g″*	49	40
vv′	130	30	*o′o″*	69	32			
zz′	141	51	*ss′*	86	0			

FIG. 563.

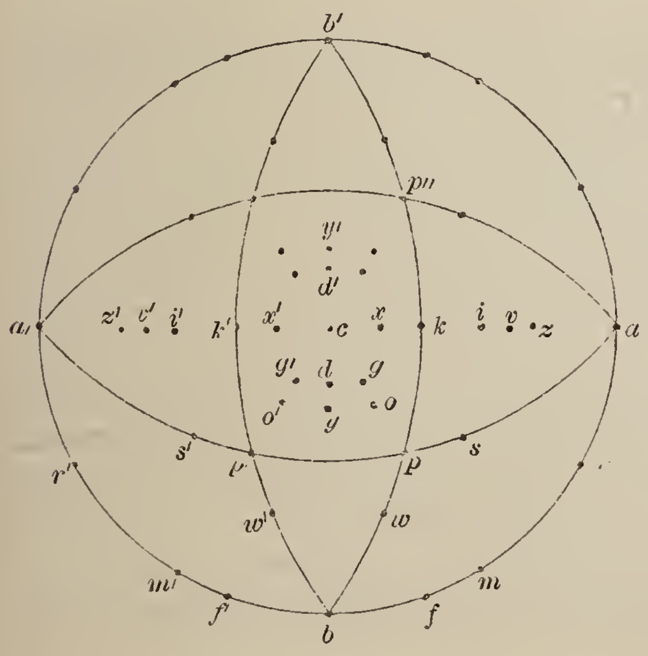


FIG. 564.

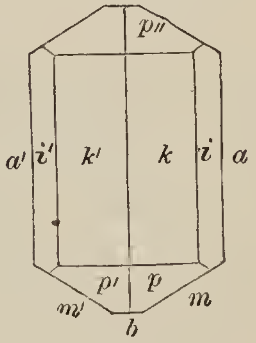
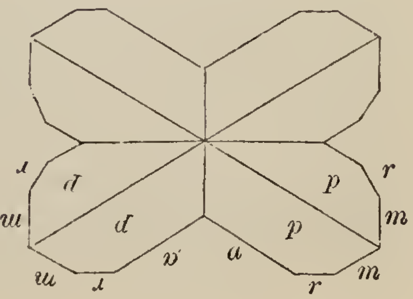


FIG. 565.



Combinations. *pi..m.a.r*, *mi.a.y*, *mpia..c.v.z*, *pmia.z.x.r.by*, *bwmpsryokixac*. The faces *p* sometimes striated parallel to their intersections with *i* or *m*; the faces *a* almost always striated parallel to their intersections with *i*, and also slightly parallel to their intersections with *m*; *x*, *k*, *i*, *v*, *z* striated parallel to their intersections with each other; *c*, usually rough. Twins. Twin-face *m*. Cleavage. *m*, *i*, tolerably perfect; *a*, *x*, traces. Fracture conchoidal. Transparent...translucent. Lustre adamantine...resinous. R = 1·813...2·084. For rays in a plane parallel to *a* and polarized in that plane $\mu = 2·067$. The optic axes lie in a plane parallel to *a*, and make angles of 4° 8′ with a normal to *c*. When seen in air through the faces *c*, they appear to make angles of about 8° 34′ with a normal to *c*. Colourless, white, greyish, yellowish-white, lead-grey; sometimes green or blue from an admixture of carbonate of oxide of copper. Streak white. Rather brittle. H = 3·5. G = 6·4...6·6.

Decrepitates violently when heated. Before the blowpipe on charcoal becomes yellow, and is reduced. Soluble with effervescence in nitric acid. The solution yields a precipitate with sulphuric acid. With hydrochloric acid a crystalline chloride of lead is produced.

$\dot{\mathrm{P}}\mathrm{b}\ddot{\mathrm{C}}$, carbonic acid 16·47, oxide of lead 83·53.

Analyses of cerussite *a* from Leadhills by Klaproth, *b* from Nertschinsk by John, *c* from Griesberg by Bergemann, *d* from Benkhausen near Allendorf by Schnabel:—

	a	*b*	*c*	*d*
Carbonic acid	16	15·5	16·49	16·07
Oxide of lead	82	81·4	83·51	83·93

Some varieties contain a very small quantity of carbonate of oxide of silver. A variety from Monte Poni in Sardinia, G = 5·9, contains 7·02 per cent. of carbonate of oxide of zinc.

In crystals; reniform, compact and earthy masses; pseudomorphous after galena, anglesite, leadhillite, baryte, fluor.

Is found at Przibram, Mies and Bleistadt in Bohemia, Bleiberg in Carinthia, Rezbanya in Hungary, Zschopau and Johann-Georgenstadt in Saxony, Zellerfeld and Clausthal in the Harz, Griesberg in the Eifel, Tarnowitz in Silesia, Badenweiler in Baden, Müsen and Siegen in Westphalia, La Croix, Markirch, Huelgoët and Poullaouen in France, Riddensk in the Altai, Ildekansk, Taininsk, Nertschinsk and Kolywan in Siberia, Beeralston in Devonshire, St. Agnes in Cornwall, Alston Moor and Keswick in Cumberland, in Derbyshire, at Leadhills and Wanlockhead in Scotland.

402. ARAGONITE.—Arragonite; Phillips, Hauy. Prismatisches Kalk-Haloid; Mohs. Arragonit; Hausmann, Haidinger.

Prismatic. 011,010=40° 50′; 101,001=35° 47′; 110,100=58° 5′.

a 100, *b* 010, *c* 001, *u* 011, *x* 102, *k* 101, *l* 302, *i* 201, *v* 301, *e* 501, *q* 601, *m* 110, *p* 111, *n* 212, *s* 211.

bc	90°	0′	*ss′*	86°	36′	*nn′*	63°	55′
ca	90	0	*ss″*	66	49	*nn″*	50	18
ab	90	0	*s′s″*	123	10	*n′n″*	85	30
uu′	98	20						
xx′	39	38						
kc	35	47						
ka	54	13						
kk′	71	34						
ll′	94	28						
ii′	110	30						
vv′	130	22						
ee′	148	59						
qq′	153	58						
ma	58	5						
mm′	63	50						
pp′	50	28						
pp″	86	23						
p′p″	107	29						

FIG. 566.

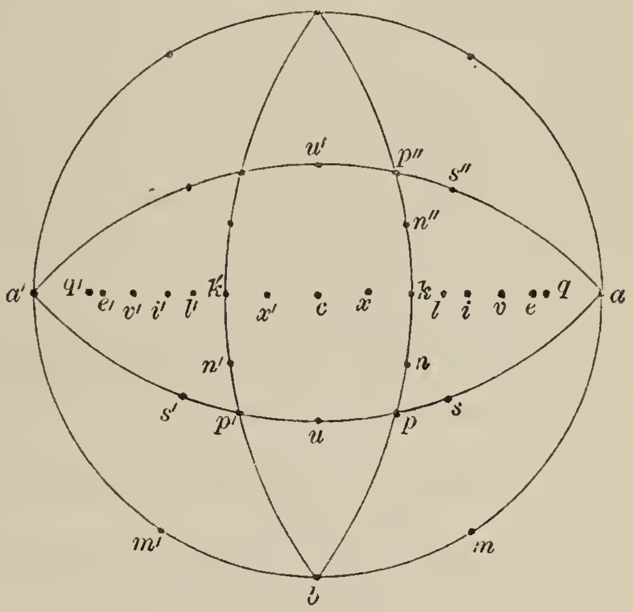


FIG. 567.

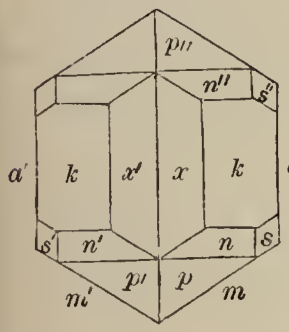


FIG. 568.

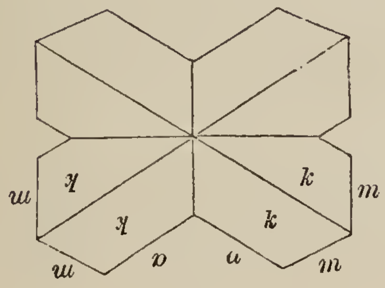
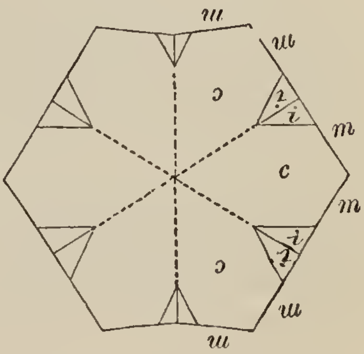


FIG. 569.



An increase of temperature of 100° c diminishes *mm′* by 2′·8, and increases *kk′* by 5′·5. Combinations. *cm*, *im*, *cim*, *kma*, *xksma*, *xkma..n.p.s.i.v.e.u.* Twins. Twin-face *m*. *mu* = 52° 20′, *av* = 62° 50′. Sometimes a crystal is united to each of two others. Cleavage. *a*, distinct; *k*, *m*, less perfect. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous, inclining to resinous on the surface of fracture. At

18° C the indices of refraction, for Fraunhofer's lines, of rays in planes parallel to *a*, *b*, *c*, and polarized in those planes respectively, are :—

B	1·68061	1·67631	1·52749
C	1·68203	1·67779	1·52820
D	1·68589	1·68157	1·53013
E	1·69084	1·68634	1·53264
F	1·69515	1·69053	1·53479
G	1·70318	1·69836	1·53882
H	1·71011	1·70509	1·54226

At 82° C the three indices for the line F are 1·69421, 1·68967, 1·53416. The optic axes lie in a plane parallel to *b*. When seen in air, through the faces *c*, they appear to make angles of 15° 27′ with a normal to *c*. Colourless, white passing into grey, wine-yellow, honey-yellow, green, blue. Streak greyish-white. Brittle. H = 3·5...4·0. G = 2·93...3·01.

In the matrass, a little below a red heat, swells, intumesces and falls into a coarse powder, and a trace of water escapes. Before the blowpipe becomes caustic. The varieties containing strontian impart a red colour to the flame. Soluble with effervescence in nitric acid, and in hydrochloric acid. The solution in hydrochloric acid evaporated to dryness, and mixed with alcohol, burns with a red flame when strontian is present. Phosphoresces when heated.

$\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$, carbonic acid 44·00, lime 56·00.

Many varieties of aragonite contain a small quantity of carbonate of strontian, others carbonate of oxide of lead or carbonate of protoxide of manganese.

Analyses of aragonite *a* from the Kaiserstuhl, *b* from Nertschinsk, *c* from the Blaue Kuppe, *d* fibrous, from Tschopau, *e* from Waltsch, *f* crystals from Molina in Aragon, all by Stromeyer :—

	a	*b*	*c*	*d*	*e*	*f*
Carbonate of lime .	97·10	97·98	96·18	98·00	98·95	95·68
Carbon. strontian .	2·46	1·09	2·24	1·01	0·51	4·01
Hydrate red ox. iron	—	—	0·22	0·14	0·14	—
Water	0·41	0·26	0·31	0·21	0·20	0·30

Analyses of aragonite *g* columnar, from Bastènes, *h* from Leogang by Stromeyer, *i* from Herrengrund, G = 2·93, *k* from Rezbanya, G = 2·86, by Nentwich, from Tarnowitz in Silesia (tarnowicite), G = 2·98...3·01, *l* by Böttger, *m* by Kersten :—

	g	*h*	*i*	*k*	*l*	*m*
Carbon. lime	95·30	99·13	98·62	99·31	95·94	97·81
Carbon. stron. . .	4·10	0·72	0·99	0·06	—	—

	g	*h*	*i*	*k*	*l*	*m*
Carbon. ox. lead . .	—	—	—	—	3·86	2·19
Carbon. ox. copper .	—	—	—	0·19	—	—
Red ox. iron . . .	—	—	0·11	—	—	—
Water	0·60	0·15	0·17	0·33	0·16	—

A fibrous variety from Dufton in Cumberland (satin spar) contains 4·25 per cent. of carbonate of protoxide of manganese.

The aragonite deposited by the hot springs at Carlsbad (sprudelstein) consists, according to Berzelius, of—carbonate of lime 97·00, carbonate of strontian 0·32, fluoride of calcium 0·69, phosphates of lime, alumina and oxide of iron 0·59, water 1·40.

In attached and imbedded crystals, fibrous and compact masses, in globular and coralloid shapes having a drusy surface.

Is found in gypsum at Molina in Aragon and Mingranilla in Valencia, at Bastènes near Dax in the Landes, in basaltic rocks on the mountain of Cziczow near Horschnetz, near Tschopau, Töplitz, Kolosoruk and Waltsch in Bohemia, the Eifel, the Kaiserstuhl in Baden, Hofgeismar in Hessia, on the Blaue Kuppe near Eschwege, in many places in Auvergne, Leogang in Salzburg, Falkenstein near Schwatz, and other places in the Tyrol, Herrengrund in Hungary, Nertschinsk in Siberia, Greenland; in beds of brown iron ore at Saalfeld and Kamsdorf in Thuringia, the Harz, Stiria; in Serpentine in the valley of St. Nicholas in Piedmont; in the lavas of Vesuvius and Iceland; in the matter deposited by the hot springs of Carlsbad; fibrous and massive at Dufton in Cumberland. The coralloid varieties are found at Eisenerz in Stiria, Hüttenberg in Carinthia, Hungary, Transylvania, Devonshire, Buckinghamshire, at Leadhills, and on the coast of Galloway in Scotland.

When carbonate of lime crystallizes from its solution in water containing carbonic acid, at the temperature of boiling water, or is precipitated by pouring a boiling hot solution of chloride of calcium into a solution of carbonate of ammonia, also boiling hot, it takes the form of aragonite. The specific gravity of the precipitate = 2·949. When it crystallizes from a solution at the ordinary temperature of the atmosphere, or from fusion, it takes the form of calcite. The specific gravity of a crystal of aragonite is reduced by ignition to that of calcite.

403. STRONTIANITE.—Strontianite; Phillips. Strontiane carbonatée; Hauy. Peritomer Hal-Baryt; Mohs. Strontianit; Hausmann, Haidinger.

Prismatic. 011,010=40° 5′; 101,001=35° 54′; 110,100=58° 39′.

a 100, *c* 001, *t* 012, *k* 101, *l* 302, *i* 201, *z* 401, *q* 601, *ζ* 801, *χ* 12 0 1, *m* 110, *o* 112, *p* 111, *θ* 332, *h* 221, *φ* 331, *λ* 441, *ξ* 881, *ρ* 445.

ca	90°	0′	*mm′*	62°	41′	*hh′*	58°	37′
tt′	61	26	*oo′*	34	33	*hh″*	107	2
kc	35	54	*oo″*	58	23	*h′h″*	140	28
ka	54	6	*o′o″*	69	39	*φφ′*	60	46
kk′	71	48	*ρρ′*	45	31	*φφ″*	112	18
ll′	94	44	*ρρ″*	78	53	*φ′φ″*	153	3
ic	55	22	*ρ′ρ″*	96	7	*λλ′*	61	35
ia	34	38	*pp′*	49	59	*λλ″*	114	24
ii′	110	44	*pp″*	87	49	*λ′λ″*	159	38
zz′	141	54	*p′p″*	108	35	*ξξ′*	62	34
qq′	154	4	*θθ′*	55	57	*ξξ″*	116	34
ζζ′	160	24	*θθ″*	110	46	*ξ′ξ″*	169	44
χχ′	166	52	*θ′θ″*	128	48			

FIG. 570.

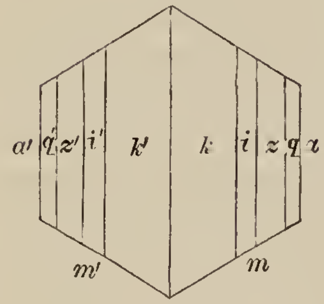


FIG. 571.

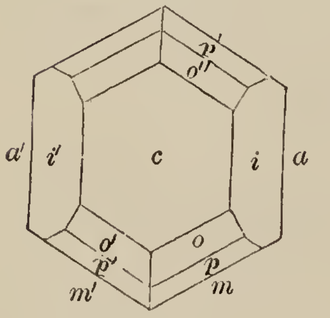
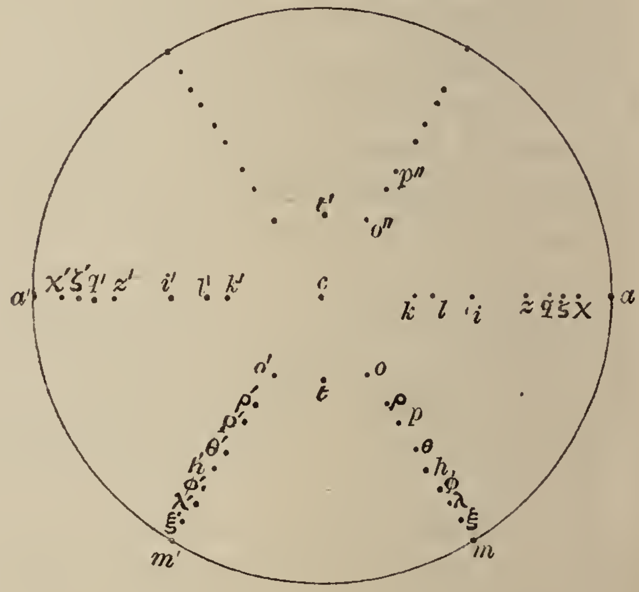


FIG. 572.



Combinations. *ξq*, *ξζ*, *cam*, *pami*, *pcamo*, *cakmθ*, *camρθ*, *cakmzθ*, *pcamhiz*, *camρξθχ*. The faces *c* often rough, or striated parallel to their intersections with *i*. *m*, *ξ*, *q*, *ζ*, *χ* striated deeply parallel to their intersections with *c*, and consequently often curved. Twins. Twin-face *m*. Cleavage. *m*, tolerably perfect; *i*, less distinct; *a*, very faint traces. Fracture uneven. Transparent…translucent. Lustre vitreous, inclining to resinous on the surface of fracture. Colourless, white passing into grey, yellow, green; pale wine-yellow, pale asparagus and apple-green. Streak white. Brittle. H = 3·5. G = 3·59…3·65.

Intumesces before the blowpipe, shines brightly, imparts a red colour to the flame, and in a strong heat melts on the thinnest edges. Soluble with effervescence in hydrochloric and nitric acids. Paper moistened with the hydrochloric solution, and afterwards dried, burns with a red flame. The solution, even when very dilute, yields a precipitate with sulphuric acid.

$\dot{Sr}\ddot{C}$, strontian 70·13, carbonic acid 29·87.

Analyses of strontianite *a* from Strontian, *b* from Bräunsdorf, both by Stromeyer:—

	a	*b*
Carbonic acid	30·31	29·95
Strontian	65·60	67·52
Lime	3·47	1·28
Oxides of iron and mangan. .	0·07	0·09
Water	0·08	0·07

Analyses of strontianite from Clausthal *c* white, *d* yellow, both by Jordan, *e*, *f* from Strontian, both by Thomson, from Hamm *g* by Becks, *h* by Schnabel:—

	c	*d*	*e*	*f*	*g*	*h*
Carbon. stron. . .	92·87	92·75	93·43	91·08	94·70	91·71
Carbon. lime . . .	6·50	6·50	6·28	8·64	5·22	7·89
Carbon. protox. iron .	—	0·36	0·01	0·08	—	—
Carbon. protox. man.	—	—	—	0·10	—	—
Water	0·25	0·25	—	—	0·08	—
Silica and loss . . .	—	—	—	—	—	0·40

In attached crystals, which are often acicular and united in groups; columnar, fibrous and granular masses.

Occurs in veins in the older rocks, limestone, clay, iron-stone, basalt. Is found at Strontian and Leadhills in Scotland, in Yorkshire, at Bräunsdorf near Freiberg, the Bergwerkswohlfahrt mine near Clausthal in very perfect crystals, Leogang near Salzburg, Hamm in Westphalia, Gaveradi in the Grisons, the Giant's Causeway, Starachowice in Poland, Schoharie and Marcellus in New York, Popayan in Peru.

404. WITHERITE.—Witherite; Phillips. Baryte carbonatée; Hauy. Diprismatischer Hal-Baryt; Mohs. Witherit; Hausmann, Haidinger.

Prismatic. 011,010=38° 45′; 101,001=36° 33′; 110,100=59° 15′.

a 100, *c* 001, *x* 102, *k* 101, *i* 201, *m* 110, *p* 111, *o* 112.

ac	90° 0′		*ia*	34° 0′		*pp″*	90° 3′	
xa	69 39		*ii′*	112 0		*p′p″*	110 49	
xx′	40 42		*ma*	59 15		*oo′*	34 56	
ka	53 27		*mm′*	61 30		*oo″*	60 35	
kk′	73 6		*pp′*	49 47		*o′o″*	71 53	

FIG. 573.

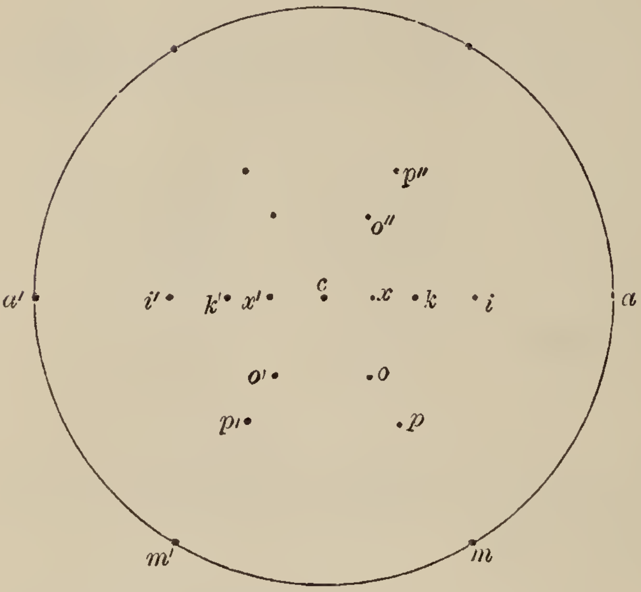
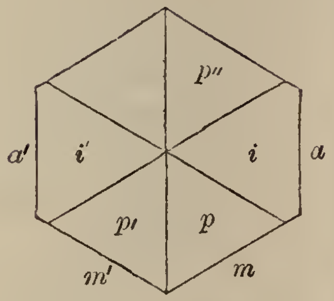


FIG. 574.



Combinations. *ki.ma*, *ok.c.ma*, *cma.pi*, *xma.ki*. The faces *m* striated parallel to their intersections with the faces *p*; *i* striated parallel to their intersections with *p*. Twins. Twin-face *m*. Cleavage. *m*, distinct; *a*, *i*, imperfect. Fracture uneven. Semi-transparent...translucent. Lustre vitreous; on surfaces of fracture resinous. White passing into yellowish or greyish-white, sometimes inclining to green or red. Brittle. H = 3·0...3·5. G = 4·2...4·4.

Before the blowpipe imparts a yellowish-green colour to the flame, and melts into an alkaline enamel. On charcoal intumesces, becomes caustic and sinks into the charcoal. Soluble with effervescence in dilute hydrochloric acid. The solution, after being largely diluted with water, yields a copious precipitate on the addition of sulphuric acid.

$\dot{\mathrm{Ba}}\ddot{\mathrm{C}}$, barytes 77·64, carbonic acid 22·36.

Analyses *a* by Withering, *b* by Bucholz, *c* by Beudant:—

	a	*b*	*c*
Carbonic acid	20·8	20·00	22·5
Barytes	78·6	79·66	77·1
Lime	—	—	0·4
Water	1·0	0·33	—

In attached crystals; more frequently in globular, reniform and columnar masses.

Occurs usually in veins of galena, in transition and carboniferous rocks, also in veins in granite and porphyry. Is found in lead mines at Anglesark in Lancashire, Alston Moor in Cumberland, Fallowfield and Dufton Fell in Durham, in Westmoreland, Shropshire, Flintshire; in beds near Peggau and Neuberg in Stiria; at Leogang near Salzburg, Tarnowitz in Silesia, Szlana in Hungary, Schlangenberg in Siberia, Sicily, Chile.

405. ALSTONITE.—Baryto-calcite en prisme droit; Dufrénoy. Alstonit; Hausmann, Haidinger.

Prismatic. 011,010=38° 39′; 101,001=36° 27′·5; 110,100=59° 25′·5.

a 100 cleavage, *k* 101, *i* 201, *m* 110, *p* 111, *h* 221.

ii′	111°	50′	*p′p″*	110°	54′	
kk′	72	55	*hh′*	57	30	
mm′	61	9	*hh″*	109	0	(fig. 574.)
pp′	49	33	*h′h″*	142	0	
pp″	90	20				

Combinations. *pi*, *pmi*. Twins. Twin-face *m*. Cleavage. *m*, *a*, tolerably distinct. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous, on the surfaces of fracture resinous. Colourless, greyish-white. Streak white. H = 4·0...4·5. G = 3·65...3·70.

Decrepitates and phosphoresces before the blowpipe. Soluble in acids with effervescence.

$\dot{Ba}\ddot{C} + \dot{Ca}\ddot{C}$, with a variable quantity of $\dot{Sr}\ddot{C}$.

Analyses of alstonite *a* from Bromley-Hill by Johnston, *b* from Fallowfield by Delesse:—

	a	*b*
Carbonate of barytes	62·16	65·31
Carbonate of lime	30·29	32·90
Carbonate of strontian	6·64	1·10
Silica	—	0·20
Oxide of manganese	—	0·16

Is found in veins with galena at Bromley-Hill near Alston Moor, and at Fallowfield near Hexham.

The substance $\dot{Ba}\ddot{C} + \dot{Ca}\ddot{C}$ appears to be dimorphous. In alstonite its crystals, isomorphous with aragonite, cerussite, strontianite and witherite, belong to the prismatic system; in barytocalcite they belong to the oblique system.

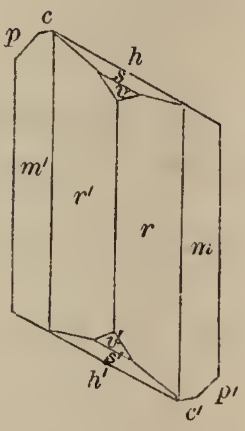
406. BARYTOCALCITE.—Hemiprismatischer Hal-Baryt; Mohs. Barytocalcit; Hausmann, Haidinger.

Oblique. 101,100 = 61° 0′; 111,010 = 53° 27′; 101,001 = 41° 26′.

c 001, *h* 101, *p* $\bar{1}01$, *m* 110, *r* 130, *s* 111, *v* 121.

hc	41°	26′	*vv′*	68°	0′
pc	32	26	*vh*	56	0
mm′	84	52	*sh*	36	33
rr′	33	54	*sp*	77	6
ss′	106	54			

FIG. 575.



Combinations. *sm*, *csphmr*. The faces *h* striated parallel to their intersections with *s*; *m*, *r* striated parallel to their intersections with each other. Cleavage. *s*, perfect; *p*, less perfect. Fracture imperfect conchoidal...uneven. Transparent...translucent. Lustre vitreous, inclining a little to resinous. Greyish, yellowish or greenish-white. Streak white. Brittle. H = 4·0. G = 3·6...3·7.

Before the blowpipe imparts a yellowish-green colour to the flame and becomes alkaline, but does not melt. With borax fuses with effervescence into a clear glass, to which a hyacinth-red colour is imparted by the hepar formed. With soda is decomposed; the barytes sinks with the soda into the charcoal, leaving the lime behind. Is soluble with effervescence in hydrochloric and in nitric acid. The solution when very dilute yields a precipitate on the addition of sulphuric acid.

$\dot{\mathrm{B}}\mathrm{a}\ddot{\mathrm{C}} + \dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$, carbonate of barytes 66·31, carbonate of lime 33·69.

Analyses of barytocalcite *a* by Children, *b* by Delesse:—

	a	*b*
Carbonate of barytes	65·9	66·20
Carbonate of lime	33·6	31·89
Silica	—	0·27

In attached crystals, and massive, in veins in mountain limestone, at Alston Moor in Cumberland.

407. CALCITE.—Carbonate of lime; Phillips. Chaux carbonatée; Hauy. Rhomboedrisches Kalk-Haloid; Mohs. Kalk; Hausmann. Calcit; Haidinger.

Rhombohedral. 100,111 = 44° 36′·6.

ȯ 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *ζ* $7\bar{2}\bar{5}$, *m* $3\bar{1}\bar{1}$, *r* 100, ♊ 711, *u* 211, *κ* 255, *e* 011, *l* $\bar{1}33$, *ε* $\bar{1}22$, *i* $\bar{7}$ 11 11, *φ* $\bar{2}33$, *h* $\bar{4}55$, *f* $\bar{1}11$, *g* $\bar{8}77$, *ψ* $\bar{5}44$, *χ* $\bar{4}33$, *η* $\bar{7}55$, *s* $\bar{3}22$, *d* $\bar{5}33$, *π* 210, *α* $51\bar{3}$, *ξ* $71\bar{5}$, *τ* 320, ♀ 730, *t* 310, *w* 410, *q* 610, *c* 710, *ν* $60\bar{1}$, *σ* $50\bar{1}$, *n* $40\bar{1}$, ☽ 11 0 $\bar{3}$, *λ* $30\bar{1}$, ♃ $50\bar{2}$, *v* $20\bar{1}$, *δ* $70\bar{4}$, ♈ $50\bar{3}$, *y* $30\bar{2}$, *ς* $40\bar{3}$, *μ* $50\bar{4}$, ♄ $60\bar{5}$, ♎ 13 0 $\bar{1}\bar{1}$, ☿ $52\bar{2}$, ♁ $73\bar{3}$, ↥ $21\bar{1}$, ♌ $95\bar{5}$, ⛢ $53\bar{5}$, *x* $21\bar{2}$, *β* $31\bar{3}$, ☉ $53\bar{4}$, *ρ* $42\bar{3}$, *p* $73\bar{5}$, ♉ $31\bar{2}$, *γ* $52\bar{3}$, *θ* $52\bar{4}$, *z* 15 $\bar{1}$ $\bar{9}$.

bo	90°	0′	*eo*	26°	15′	*go*	67°	56′
bb″	60	0	*ee′*	45	3	*gg′*	106	46
ba′	30	0	*lo*	38	17	*ψo*	71	20
ζb	13	54	*ll′*	64	54	*ψψ′*	110	16
mo	75	47	*εo*	44	37	*χo*	73	51
mm′	114	10	*εε′*	74	55	*χχ′*	112	34
ro	44	37	*io*	49	49	*ηo*	75	47
rr′	74	55	*ii′*	82	50	*ηη′*	114	10
♊*o*	33	20	*φo*	50	58	*so*	78	32
♊♊′	56	50	*φφ′*	84	33	*ss′*	116	9
uo	13	52	*ho*	55	57	*do*	82	47
uu′	23	56	*hh′*	91	42	*dd′*	118	27
κo	13	52	*fo*	63	7			
κκ′	23	56	*ff′*	101	9			

The three columns exhibit the angles between pairs of faces on opposite sides of *ob*, *ob″*, *bb″* respectively:—

ττ	35°	15′	17°	25′	125°	44′
ππ	28	39	28	39	120	40
♀♀	25	23	34	4	118	18
tt	20	36	41	55	115	5
ww	15	59	49	23	112	19
qq	10	55	57	23	110	15
cc	9	32	59	46	108	56
νν	11	59	77	49	85	59
σσ	14	27	77	54	82	3
nn	18	7	78	5	76	8
☽☽	19	47	78	4	73	26
λλ	24	10	77	49	66	15
♃♃	28	53	77	8	58	26
vv	35	36	75	22	47	2
δδ	40	5	73	40	39	11
♈♈	41	46	72	54	36	8
yy	45	32	70	59	29	16
ςς	49	50	68	21	21	7
μμ	52	12	66	42	16	30
♄♄	53	34	65	36	13	32

♎	54°	13′	65°	10′	12°	25′
☿☿	51	54	38	19	80	4
♅♅	55	4	35	54	79	14
♐♐	62	37	30	7	77	35
♌♌	68	6	25	53	76	56
♂♂	91	42	20	40	52	30
xx	87	51	26	44	44	42
ββ	80	2	37	30	30	39
⊙⊙	83	9	21	52	62	52
ρρ	77	8	28	53	60	47
pp	72	26	34	20	55	20
♉♉	64	26	41	37	51	30
αα	54	30	54	30	47	24
γγ	64	43	37	28	62	10
θθ	75	22	35	36	47	2
ξξ	57	21	57	21	32	38
zz	37	7	79	5	34	32

FIG. 576.

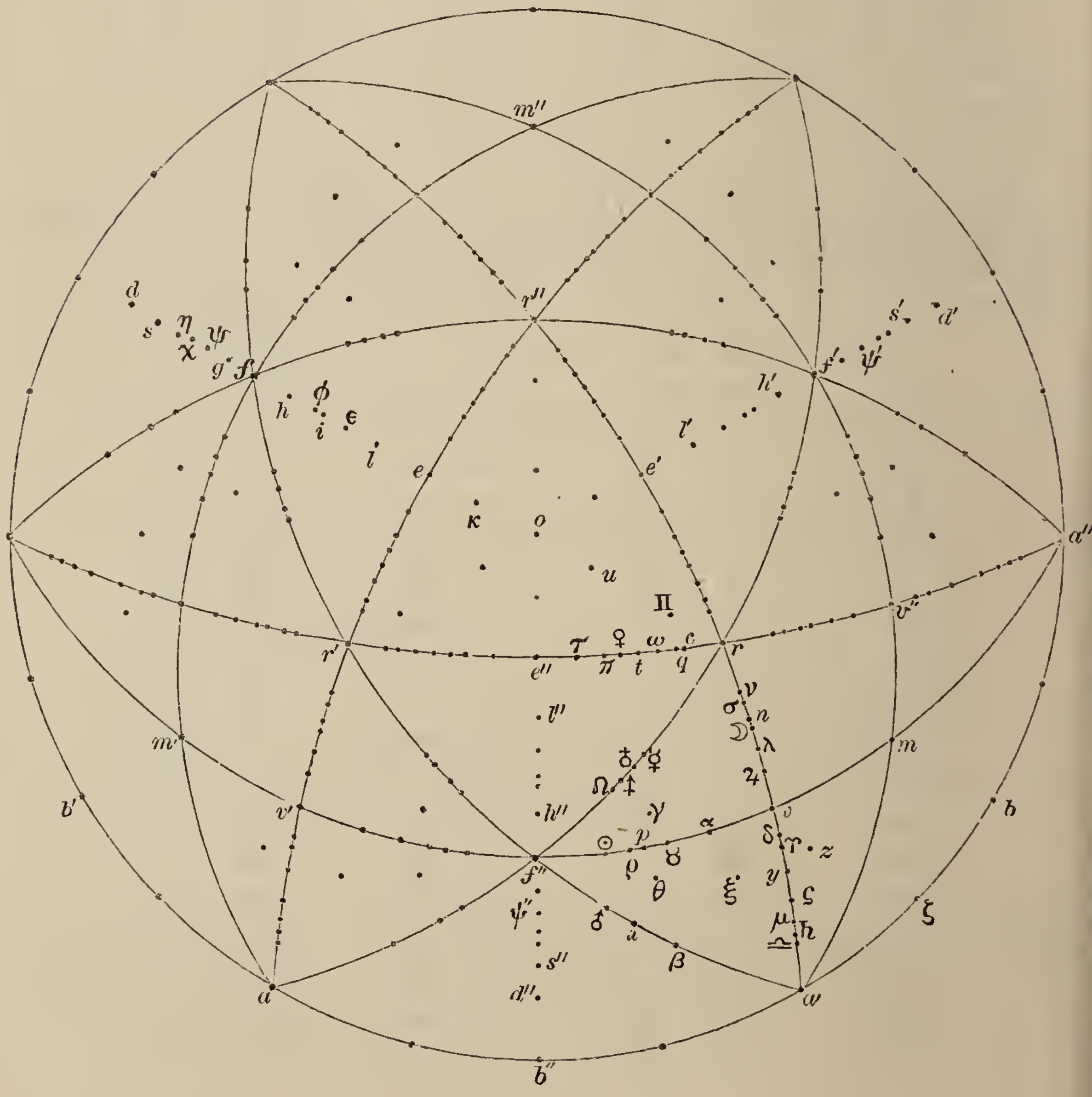


FIG. 577.

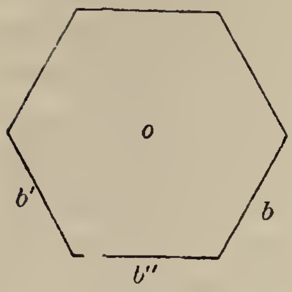


FIG. 578.

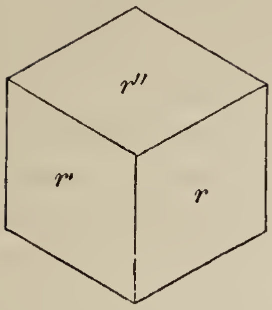


FIG. 579.

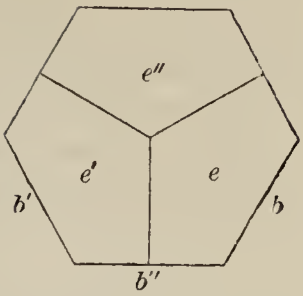


FIG. 580.

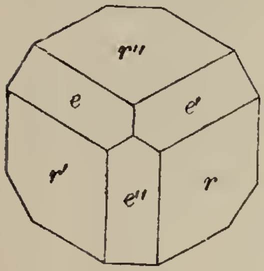


FIG. 581.

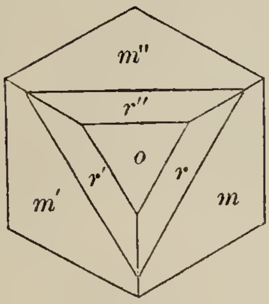


FIG. 582.

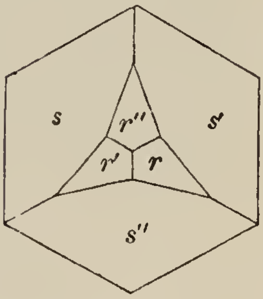


FIG. 583.

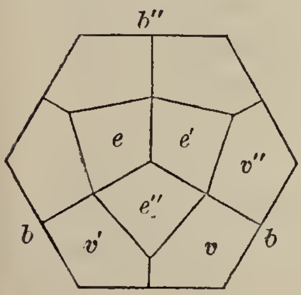


FIG. 584.

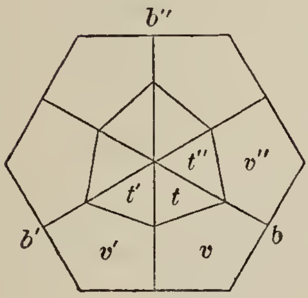
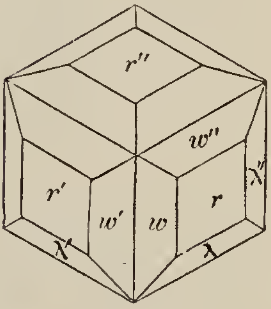


FIG. 585.



An increase of temperature of 100° C alters by 8′·6 the angle between the principal cleavages, making them assume a position more nearly at right angles to each other. Forms and combinations. *r, ε, e, u, f, m, h, o.e.r.f.m.h.v.μ.b, e.o.r.φ.f.γ.λ.μ.b.a, r.e.f.m.φ.δ.♎.b.a.o, r.ew.π.♂ b, f.e.r.m.v.x.b.a, m.o.r.v, h.o.φ, φ.e.r.h, v.o.r.f.m.l.φ.t.b.a, v.rl.of.rlφ, y.f.χ.m, y.eb.xa.fr, μ.o.e, b.o.g.r.h.φ.f.τ.t.λ.v, a.fr.yr, or.f.b, ob.ah.v.☉.y.λ.ς.mς, ef.o.vb.m-v.mvbo, fa.r.y.reb.vy, fb.θ, fm.orv.rv ♉ a, mo.r.a.rvςa, me.va.vs, mv.e.f.b.eb.efb.lfνa.ςb.tra.of, erm ♉ vb, sm.r.rl, se.o.vb, vb.e.f.-p.rν.erlfm, vtb.e.ef.erφb, vzm.d.b, vym.d.r.rb.rzb, xf.♊.r.v.ve.vr, μm.v.h, bo.e.f.φ.h.re.ef.ew.ms, be.f.l.h.v.fv.rfv.vms, bv.r.e.fp.eξ.tπε, br.f.ε.e, oba.e.m.fm, ofybζ, o ♈ ♌ fρa, etrfxmyβd, rfm ♃ vαa, by, c ♈, wς, ev, e ♎, g ♀, g ♎, emf, ret, hf ☉, rwς, mcμ, o.l.ε.s.y, obf.♊.y, obeh.w.m ♎. ♀, abf.θ.mv, bm.v.eμ.ryv, be.♎.☉, ab.et.☿θ, om ♎.η, mfχy ♎ x, obrmvς, oaifρ ♌, a.v.θ.mf ♎.* The faces *o* are usually rough; *e* striated parallel to their intersections with *r*; *τ* rather curved; *t*, *w* striated parallel to their intersections with *e*; *π*, *a* striated parallel to their intersections with *r*. Twins. 1. Twin-plane *o*. The axes of the rhombohedrons are parallel. 2. Twin-plane *e*. The axes of the rhombohedrons make with each other an angle of 127° 30′. This composition is sometimes frequently repeated, producing striæ on the faces of cleavage. The planes of union parallel to a face *e* have been mistaken for cleavages. 3. Twin-plane *r*. The axes of the rhombohedrons make with each other an angle of 90° 46′. 4. Twin-plane *f*. The axes of the rhombohedrons make with each other an angle of 53° 46′. Cleavage. *r*, very easily obtained, even and often very perfect; *o*, *b*, *a*, *v*, traces more or less faint. Fracture conchoidal, perfect but not easily obtained. Transparent...translucent. Lustre vitreous; *o* inclining to pearly. Most of the forms bright. *ε*, *l*, *h* less bright...dull. The spheroidal wave surface is oblate. At 17°·75 C the indices of refraction corresponding to Fraunhofer's lines are—

	μ	μ'
H	1·68330	1·49780
G	1·67617	1·49453
F	1·66802	1·49075
E	1·66360	1·48868
D	1·65850	1·48635
C	1·65452	1·48455
B	1·65308	1·48391

An increase of temperature of 64° C increases the index of the extraordinary ray F from 1·49075 to 1·49118. The index of the ordinary ray is not altered. Colourless, white, only accidentally grey, blue, green, yellow, red, brown, black. Streak white. Brittle. H = 3·0. G = 2·69...2·75. Acquires vitreous electricity by pressure.

Infusible before the blowpipe; becomes caustic and shines with peculiar brightness as soon as all the carbonic acid is expelled. Soluble in borax and salt of phosphorus, forming a transparent bead. Easily and perfectly soluble, with effervescence, in hydrochloric and in nitric acid. Exposed to a high temperature under pressure, or surrounded by an atmosphere of carbonic acid, it fuses without being decomposed, and is converted into a crystalline mass.

$\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$, carbonic acid 44·00, lime 56·00.

Analyses of calcite *a* from Iceland by Phillips, *b* from Iceland, *c* from Andreasberg, both by Stromeyer, *d* from Brilon by Schnabel, *e* from the calamine mines of Olkucz by Gibbs, *f* from Andreasberg by Hochstetter:—

	a	*b*	*c*	*d*	*e*	*f*
Carbonic acid	44·0	43·70	43·56	43·52	43·81	42·20
Lime	55·5	56·15	55·98	55·30	50·76	54·40
Magnesia	—	—	—	0·13	0·85	—
Protox. iron . . .	(and $\dot{\bar{M}}$n	0·15	0·36)	—	0·51	1·55
Ox. zinc	—	—	—	—	4·07	—
Water	—	—	0·10	1·07	—	—
Silica	—	—	—	—	—	1·85

Analyses of calcite *g*, *h* from cavities in the calamine of Altenberg by Monheim, *i* from Münden by Ahrend, *k* from Moutiers by Berthier:—

	g	*h*	*i*	*k*
Carbonate of lime	89·27	89·56	95·86	96·0
Carbonate of magnesia . . .	—	—	0·37	—
Carbonate of protox. iron . .	9·31	8·23	3·53	3·0
Carbonate of protox. man. . .	—	0·69	0·82	1·0
Carbonate of ox. zinc	1·64	1·01	—	—
Silica	—	0·18	—	—

In attached and imbedded crystals, massive, and pseudomorphous after aragonite, gypsum, gaylussite, felspar, augite.

The crystals are found in drusy cavities and veins, less frequently in beds, in limestone and almost every other kind of rock, and accompanying a great variety of minerals; and in the cavities of amygdaloidal rocks. The forms *o*, *b*, *r*, *e*, *ε*, *h*, *v*, *y*, *x* and their combinations are frequently found in veins at Andreasberg in the Harz; the forms *r*, *e*, *g*, *b* in the veins of the western Harz; the forms *e*, *b* on the Pfaffenberg and Meiseberg; *v*, *y*, *e*, *b* in veins of hematite near Andreasberg and Zorge; *v* in the manganese veins of Ihlefeld; *m*, *f*, *η* in nodules of iron and manganese ores at Iberg. The form *v* occurs frequently in Derbyshire, and *e* in Cumberland, in veins containing galena. The combinations *r.ew.π.* ♂ *b* are found near Prague; the combinations *ef.o.vb.mv.mvbo* and *fa.r.y.reb.vy* in Carinthia and Bohemia. The forms *e*, *m*, *b* prevail in the mining districts of Saxony and Bohemia. At Fontainbleau in France crystals of the form *f* occur containing a mechanical mixture of from 58 to 95 per cent. of fine quartz sand. Very large transparent crystals are found in a cavity in trap, with stilbite, on the north shore of Eskifiord on the east coast of Iceland. Remarkable crystals are also found in Baden at Wiesloch and Donaneschingen; in France, Poictiers, Chalances and Paris; in the United States, &c. Calcite has been found in pseudomorphous crystals after gaylussite at Obersdorf near Sangerhausen in Thuringia, at Kating not far from Tönningen, Eiderstedt in Schleswig, and in some of the neighbouring islands, and in the frontal sinuses of the skull of the ursus spelæus in a cavern in the Tufna near Hermanecz not far from Neusohl in Hungary. Lamellar varieties, in very thin parallel layers bounded by the faces *o*, (schieferspath) occur in beds of granular limestone in Saxony, Bohemia, Norway, Cornwall, in Glen Tilt and Assynt in Scotland, and in the county of Wicklow. Granular limestone, or statuary marble, consists of minute crystals, and sometimes forms entire mountains, but more frequently occurs in beds in gneiss, porphyry and mica slate. Statuary marble is found in the islands of Paros, Naxos and Tenos, Pentelicus and Hymettus near Athens, Carrara on the Gulf of Genoa, Schlanders in the Tyrol. The compact varieties (marble or limestone) variously coloured by an admixture of silica, alumina, oxide of iron, carbon, form the greater part of the transition and newer formations. Some of these, the oolites, consist of an aggregation of minute globules. Stalactites and tufa are continually forming, being deposited from water containing carbonate of lime dissolved in an excess of carbonic acid. Stalactites form mamillated or long fibrous masses in fissures and caverns of limestone rocks. Tufa, an alluvial deposit from calcareous springs, is formed in immense quantities near Terni, Tivoli and other places in Italy. Chalk appears to consist, in a great measure, of an aggregation of fossils, chiefly infusorial.

408. ANKERITE.—Paratomes Kalk-Haloid; Mohs. Ankerit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 43° 54′.

o 111, *e* 011, *r* 100.

ro	43°	54′	
rr′	73	48	
eo	25	42	(figs. 586, 580.)
ee′	44	6	

Combinations. *or*, *er*. Twins. 1. Twin-face *o*. 2. Twin-face *e*. A frequent repetition of this composition produces the striæ sometimes observed on the cleavages parallel to their intersections with *o*. The faces *o* rough; *e*, deeply striated parallel to their intersections with *r*. Cleavage. *r*, perfect. Fracture uneven. Translucent...slightly translucent. Lustre vitreous, sometimes inclining to pearly. Yellowish-white... yellowish-grey; becomes brown by exposure to the air. Streak white. Brittle. H = 3·5...4·0. G = 3·040...3·085.

Before the blowpipe becomes black and magnetic. With soda gives indications of manganese. Imparts the colour of iron to glass of borax. Soluble with effervescence in nitric acid.

Analyses of ankerite *a* by John, *b* communicated by Haidinger, *c* by Schrötter, *d* from Golrath in Stiria by Berthier, *e* from Tinzen in the Grisons by Schweizer:—

	a	*b*	*c*	*d*	*e*
Carb. lime	50·0	48·03	50·11	51·1	46·40
Carb. magnesia	8·4	16·46	11·85	25·7	26·95
Carb. protox. iron	35·0	32·06	35·31	20·0	25·40
Carb. protox. mangan. . . .	5·0	2·97	3·08	3·0	—
Insoluble	—	—	—	—	0·75

Is found in attached crystals, granular and compact masses, on the Rathhausberg near Gastein in beds in mica slate, in Stiria at Eisenerz, on the Golrath, at Raiding near Vordernberg, Neuburg, on the Rothsol, on the Veitschalp.

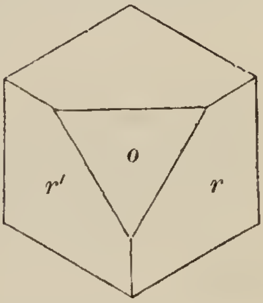
409. DOLOMITE.—Bitter Spar; Phillips. Chaux carbonatée magnesifère; Hauy. Makrotypes Kalk-Haloid; Mohs. Bitterkalk; Hausmann. Dolomit; Haidinger.

Rhombohedral. 111,100 = 43° 51′·6.

o 111, *a* $01\bar{1}$, *e* 011, *r* 100, *f* $\bar{1}11$, *m* $3\bar{1}\bar{1}$, *v* $20\bar{1}$, ɱ $4\bar{1}\bar{2}$, ϰ $51\bar{4}$. The forms ɱ, ϰ are hemihedral with parallel faces.

ao	90°	0′	*vv′*	75°	4′
aa′	60	0	*vv″*	35	28
eo	25	40	*va′*	23	58
ee′	44	3	*vr*	29	10
ro	43	52	ɱ*o*	79	25
rr′	73	45	ɱ*a′*	23	27
fo	62	31	ɱ*r*	36	21
ff′	100	24	ϰ*o*	74	58
mo	75	25	ϰ*a′*	15	28
mm′	113	53	ϰ*r*	41	56

FIG. 586.



See also figs. 578, 580, 581.

An increase of temperature of 100° C alters the angle between the cleavage planes 4′, making them assume a position more nearly at right angles to each other. Forms and combinations. *r*, *m*, *er*, *ro*, *rm*, *om*, *orm*, *arm*, *armf*, *oarfv*, *aorfmv*, *aorm*ɱ′ϰ′. The faces *o* sometimes convex, producing lenticular shapes; *e* deeply striated parallel to their intersections with *r*; *r* sometimes convex; *v* sometimes drusy. Twins. Twin-face *o*. Cleavage. *r*, perfect; the surfaces of cleavage sometimes curved; *e*, traces. Fracture conchoidal. Semi-transparent… translucent. Lustre vitreous, more or less inclining to pearly in different varieties. Colourless, white, pale green, yellow, grey, black, sometimes red, blue, sometimes brown in consequence of exposure to the atmosphere. Streak greyish-white. Brittle. H = 3·5…4·5. G = 2·80…2·95.

Infusible before the blowpipe. Some varieties turn brown or black when heated, others exfoliate. With fluxes it usually gives indications of iron and not unfrequently manganese. In lumps it does not effervesce in hydrochloric acid. In powder it is soluble with effervescence, but not entirely unless heated.

$\dot{Ca}\ddot{C}$, $\dot{Mg}\ddot{C}$. Many varieties contain also carbonate of protoxide of iron or of manganese, or both together.

Analyses of dolomite *a* in colourless crystals from Jena by Sukow, *b* granular, from Vaage in Gulbrandsdalen by Scheerer, *c* from Tharand (tharandite) by Kühn, *d* compact, from the neighbourhood of Ihlefeld by Rammelsberg, *e* from Traversella, G = 2·629 by Pelletier, *f* granular, from the south coast of Capri by Abich:—

	a	*b*	*c*	*d*	*e*	*f*
Carb. lime	55·2	55·88	54·76	55·62	51·00	52·30
Carb. magnesia . . .	44·7	40·47	42·10	42·40	44·32	46·97
Carb. protox. iron . .	—	2·81	4·19	0·56	4·68	—

Analyses of dolomite *g* granular, from the valley of Sambuco by Abich, *h* from the Zillerthal by Meitzendorf, *i* from Spezzia by Laugier, *k* compact, from Altenberg by Monheim:—

	g	*h*	*i*	*k*
Carb. lime	56·57	56·66	55·36	54·31
Carb. magnesia	43·43	38·60	41·30	43·26
Carb. protox. iron	—	3·30	2·00	0·99
Carb. protox. mang.	—	1·70	—	0·56
Carb. ox. zinc	—	—	—	1·38
Silica	—	—	0·50	0·48

Analyses of dolomite *l*, *m* red, G = 2·921, from Przibram by Gibbs, *n* compact, from the Thüringerwald by Gerned, *o* from Dohraburg in the Tyrol, *p* from Schneeberg, both by Kühn, *q* from the Schamserthal in the Grisons by Berthier:—

	l	*m*	*n*	*o*	*p*	*q*
Carbonic acid	45·12	45·37	42·45	46·91	44·42	41·4
Lime	31·72	31·86	28·93	30·65	29·48	27·0
Magnesia	16·63	17·37	23·46	21·46	17·31	14·0
Protox. iron	1·36	1·16	3·48	2·25	7·70	8·4
Ox. cobalt	5·17	4·24	—	$\dot{Mn}$	0·21	0·2

Analyses of dolomite *r* from Kolosoruk near Bilin by Rammelsberg, *s* compact, from Liebenstein by Wackenroder, *t* compact, from the coast between Vico and Sorento by Abich, *u* granular, from Rappenau in Silesia by Rammelsberg, *v* from Kolosoruk by Kühn :—

	r	*s*	*t*	*u*	*v*
Carb. lime	61·00	63·87	65·21	75·87	85·84
Carb. magnesia . . .	36·53	33·24	34·79	24·52	10·39
Carb. protox. iron . .	2·74	0·91	—	—	5·53
Carb. protox. mang. .	—	0·07	—	—	—
Organic matter . . .	—	1·05	—	—	—

In attached and imbedded crystals, granular and columnar masses, disseminated, pseudomorphous after calcite.

The variety in white granular masses (dolomite) forms rocks by itself and beds in other rocks. A greenish variety (rautenspath) in imbedded crystals, and cleavable masses, frequently in talc, sometimes in gypsum. The red and brown varieties of lustre inclining to pearly (brown spar) is usually found in veins with various sulphides, and in clefts in basalt. Is found on St. Gotthardt, the Brenner and Greiner, Carinthia, Baden near Vienna, the Apennines; the imbedded varieties (rautenspath) in Salzburg, the Tyrol, Switzerland; in rhombohedrons (*r*) at Traversella in Piedmont; a green variety (miemit) at Miemo in Tuscany, Glücksbrunn in Thuringia, near Tharand in Saxony. Rhombohedrons with convex faces occur in basalt at Kolosoruk in Bohemia. The variety called brown spar occurs at Schemnitz in Hungary, Kapnik in Transylvania, Przibram in Bohemia, Freiberg and other places in Saxony, Clausthal in the Harz, Norway, Sweden, Scotland, England.

410. MAGNESITE. — Magnesie carbonatée cristallisée; Dufrénoy. Magnesit; Mohs, Hausmann, Haidinger.

Rhombohedral. 100,111 = 43° 4′.

r 100.

rr′ 72° 31′. (fig. 578.)

Cleavage. *r*, very perfect. Transparent…translucent on the edges. Lustre vitreous. Colourless, yellowish-white, yellow, brown, black. H = 4·5…5·0. G = 2·88…3·02.

Assumes a pale red colour when moistened with nitrate of cobalt and heated before the blowpipe. Soluble in dilute sulphuric acid.

$\dot{\mathrm{Mg}}\ddot{\mathrm{C}}$, carbonic acid 51·62, magnesia 48·38.

Analyses of cleavable magnesite *a* from Snarum by Scheerer, *b* from Salzburg by Dufrénoy, from Arendal *c* by Münster, *d* by Tonsager:—

	a	*b*	*c*	*d*
Carbonic acid	51·45	50·6	52·57	52·66
Magnesia	47·30	43·1	46·43	46·22
Protox. iron	0·79	5·2	0·87	1·12
Water	0·47	—	—	—

Analyses of compact magnesite *e* from Baumgarten, *f* from Salem, both by Stromeyer, *g* from Hrubschitz by Lampadius, *h* from Salem by Henry, *i* from Greece by Brunner:—

	e	*f*	*g*	*h*	*i*
Carbonic acid	50·22	51·83	51·0	51·0	49·49
Magnesia	47·36	47·89	47·0	46·0	51·03
Lime	—	0·28	—	—	—
Oxide of mangan. . . .	0·21	—	silica	1·5	—
Water	1·39	—	1·6	0·5	—

In crystals, globular, reniform, compact and earthy masses.

Occurs usually in serpentine. The crystallized varieties are found at Snarum and Arendal. Compact magnesite is found at Baumgarten in Silesia, Hrubschitz in Moravia, Kraubat in Stiria, Hall in the Tyrol, Salem in the East Indies.

411. BREUNNERITE.—Brachytypes Kalk-Haloid; Mohs. Breunnerit; Hausmann, Haidinger.

Rhombohedral. 100,111 = 43° 8′.

r 100, *e* 011.

rr′ 72° 37′
ee′ 43 6 (figs. 578, 580.)

Form and combination. *r*, *re*. The faces *r* even but rough. Cleavage. *r*, very perfect. Fracture conchoidal. Transparent… translucent. Lustre vitreous, inclining to pearly on the surfaces of cleavage. Colourless, yellowish-white, yellow, brown. Streak greyish-white. Brittle. H = 4·0…4·5. G = 3·0…3·2.

Infusible before the blowpipe, becoming grey or black, and frequently magnetic. Imparts the colour of iron to glass of borax. With soda sometimes yields indications of manganese. When reduced to powder is soluble in acids with the aid of heat.

$\dot{Mg}\ddot{C}$, with a variable quantity of $\dot{Fe}\ddot{C}$.

Analyses of breunnerite *a* from the Zillerthal, *b* from Fassathal, *c* from St. Gotthardt, *d* black, from Hall in the Tyrol, all by Stromeyer, *e* from the Tyrol by Brooke, *f* from the Pfitschthal in the Tyrol by Magnus :—

	a	*b*	*c*	*d*	*e*	*f*
Carb. magnesia . .	87·79	82·89	87·78	89·70	86·05	82·91
Carb. protox. iron .	13·82	16·97	10·54	8·02	13·15	15·59
Carb. protox. man. .	0·69	0·78	0·90	2·44	—	1·19
Carbon	—	—	—	0·11	—	—

Is found in single crystals, crystalline, columnar and granular masses, usually imbedded in chlorite, talc and sometimes in serpentine, more rarely in gypsum, in the Tyrol in the Zillerthal, Pfitschthal, Fassathal, Ultenthal and Hall, St. Gotthardt, Norway, Unst, the United States.

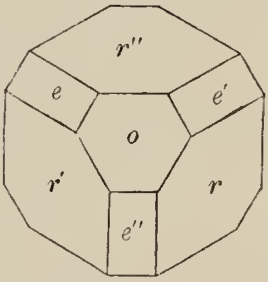
412. MESITINE.—Mesetinspath; Dufrénoy. Rhomboedrischer Parachros-Baryt; Mohs. Mesitin; Hausmann, Haidinger.

Rhombohedral. 100,111 = 43° 14′.

o 111, *b* 2$\bar{1}\bar{1}$, *r* 100, *e* 011.

bo	90°	0′	*rr′*	72°	46′
bb′	120	0	*eo*	25	11
ro	43	14	*ee′*	43	14

FIG. 587.



Combinations. *rob*, *roe*. The faces *r* smooth; *o*, *e* rounded, producing lenticular shapes. Cleavage. *r*, perfect; *e*, traces. Fracture not observable. Transparent... translucent. Lustre vitreous. Greyish and yellowish-white... yellowish-green. Becomes brown by exposure. Streak white. Brittle. H = 3·5...4·0. G = 3·35...3·417.

Decrepitates when heated. Grows black and magnetic before the blowpipe. Imparts the colour of iron to glass of borax. Soluble with feeble effervescence in hydrochloric acid and in nitric acid.

Analyses of mesitine from Traversella, G = 3·35, *a* by Fritzsche, *b* by Gibbs, *c* from Thurnberg (pistomesit), G = 3·41, by Fritzsche :—

	a	*b*	*c*
Carbonic acid	45·76	46·05	43·62
Protoxide of iron	24·18	26·61	33·92
Magnesia	28·12	27·12	21·72
Lime	1·30	0·22	—

Is found in crystals with quartz at Traversella in Piedmont, and with hematite at Thurnberg near Flachau in Salzburg.

413. CHALYBITE.—Spathose iron; Phillips. Fer oxidé carbonaté; Hauy. Brachytyper Parachros-Baryt; Mohs. Sphärosiderit; Hausmann. Siderit; Haidinger. Chalybit; Glocker.

Rhombohedral. 100,111 = 43° 23′.

o 111, *a* $01\bar{1}$, *b* $2\bar{1}\bar{1}$, *e* 011, *r* 100, *f* $\bar{1}11$, *m* $3\bar{1}\bar{1}$, *s* $\bar{3}22$, *v* $20\bar{1}$, ♒ $3\bar{1}\bar{1}$.

ao	90°	0′	*rr′*	73°	0′	*vo*	58°	35′
bo	90	0	*fo*	62	7	*va′*	24	15
aa′	60	0	*ff′*	99	54	*vr*	29	15
ba′	30	0	*mo*	75	11	♒*o*	47	30
eo	25	17	*mm′*	113	42	♒*a*	68	24
ee′	43	26	*so*	78	3	♒*r*	21	36
ro	43	23	*ss′*	115	50			

FIG. 588.

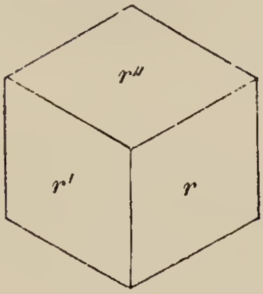


FIG. 589.

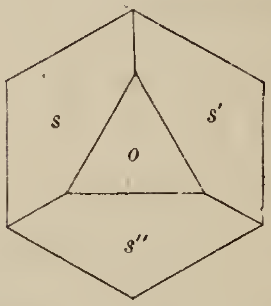
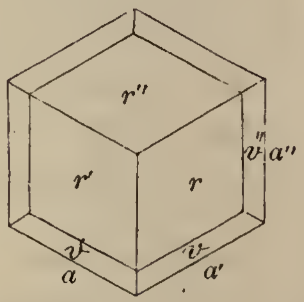


FIG. 590.



See also figs. 557, 586, 580, 582, 587.

Forms and combinations. *r*, *f*, *m*, *s*, *es*, *os*, *ems*, *rva*, *oa.re*, *r.o.e.f.s.b.a.*♒, *or.e.m.s.b.* The faces *e* striated parallel to their intersections with *r*. *e*, *r* frequently curved; *b* smooth, *m* uneven; *s* frequently uneven and curved. Twins. Twin-face *e*. Cleavage. *r*, perfect; *e*, traces. Fracture imperfect conchoidal. More or less translucent. Lustre vitreous, inclining to pearly. Yellowish-brown of various shades passing into grey, yellowish-white and red. Brown or black when decomposed. Streak yellowish-white. Brittle. H = 3·5...4·5. G = 3·70...3·92.

Before the blowpipe blackens and becomes magnetic. Imparts the colour of iron to glass of borax and salt of phosphorus. With soda usually affords indications of manganese. In powder is soluble with effervescence in warm nitric acid.

$\dot{Fe}\ddot{C}$, carbonic acid 37·93, protoxide of iron 62·07. It usually contains also variable quantities of $\dot{Mn}\ddot{C}$ and $\dot{Mg}\ddot{C}$.

Analyses of chalybite *a* fibrous, from Steinheim near Hanau by Stromeyer, *b* from Rancié near Vicdessos by Berthier, *c* from Bieber, in white crystals, by Glasson, *d* from Siegen, in yellow crystals, *e* from the Hohegrethe mine in Hachenburg, *f* from the Kirschbaum mine in Siegen, all by Karsten:—

	a	*b*	*c*	*d*	*e*	*f*
Carb. acid	38·04	39·2	38·41	38·90	38·64	38·85
Protox. iron	59·63	53·5	53·06	50·72	50·41	47·20
Protox. mangan. . .	1·89	6·5	4·20	7·64	7·51	8·34
Magnesia	—	0·7	2·26	1·48	2·35	3·75
Lime	0·20	—	1·12	0·40	—	0·63
Insoluble	—	—	0·48	0·48	0·32	0·95

Analyses of chalybite *g* from the Stahlberg near Müsen by Karsten, *h* from the Stahlberg, *i* from Hamm, both by Schnabel, *k* from Neudorf near Harzgerode, in yellow crystals, by Herter, *l* fibrous, from the Alte Birke mine near Siegen by Schnabel, *m* from Ehrenfriedersdorf by Magnus:—

	g	*h*	*i*	*k*	*l*	*m*
Carb. acid	39·19	38·50	39·19	36·92	38·22	38·35
Protox. iron	47·96	47·16	46·68	48·21	43·59	36·81
Protox. mangan. . .	9·50	10·61	9·87	12·71	17·87	25·31
Magnesia	3·12	3·23	3·91	1·79	0·24	—
Lime	—	0·50	0·35	0·37	0·08	—

Analyses of chalybite *n* from Allevard, *o* from Autun, *p* from Vizille, all by Berthier, *q* from Erzberg by Sander:—

	n	*o*	*p*	*q*
Carbonic acid	41·8	40·4	42·6	38·44
Protoxide of iron	42·8	45·2	43·6	49·61
Protoxide of manganese . .	—	0·6	1·0	0·10
Magnesia	15·4	12·2	12·8	5·18
Lime	—	—	—	6·67

Analyses of chalybite *r* crystallized, from Neudorf by Pieschel, *s* from Altenberg, in green crystals, G = 3·60, by Monheim, *t* compact, from Burgbrohl on the lake of Laach by Bischof:—

	r	*s*	*t*
Carb. protox. iron	79·34	64·04	96·72
Carb. protox. mangan.	8·69	16·56	—
Carb. magnesia	7·60	—	—
Carb. lime	5·43	20·22	3·28
Silica	—	1·10	—

In attached crystals, granular, fibrous or compact masses, globular, reniform, and pseudomorphous after calcite.

Occurs in beds in gneiss, mica slate, clay slate, transition limestone and newer rocks; in veins with metals and their sulphides; less frequently in cavities in trap rocks. The most remarkable crystals of chalybite are found in the mines of Pfaffenberg and Meiseberg at Neudorf near Harzgerode, in the Louisa and Silberne Nagel mines near Stolberg in the Harz, Holzappel in Nassau, the Stahlberg near Schmalkalden, the Stahlhäuschen mine near Lobenstein, Niederalpel in Stiria, Devonshire, Pacho in Bogotá. Chalybite occurs in large quantities in beds at Erzberg near Eisenerz in Stiria, Hüttenberg in Carinthia, the Stahlberg and Mommel near Schmalkalden, the Stahlberg near Müsen in Westphalia, the Pyrenees, Somorostro near Bilbao, Pacho in Bogotá. It occurs also in veins at Przibram, Joachimsthal and Schlackenwald in Bohemia; at Freiberg and Ehrenfriedersdorf in Saxony, Beeralstone in Devonshire, Wheal Maudlin, St. Just and many other places in Cornwall. In trap rocks at Steinheim near Hanau, and near Zittau; in beds in hematite on the Giftberg near Horzowitz in Bohemia. Clay ironstone (massive chalybite containing an admixture of clay) occurs abundantly in the coal formations of Staffordshire and South Wales, Bohemia, Moravia, Silesia, Saarbrück, Schaumburg, Osnabrück, Poland, the United States.

414. DIALLOGITE.—Carbonate of manganese; Phillips. Manganèse carbonaté; Hauy. Makrotyper Parachros-Baryt; Mohs. Rhodochrosite; Hausmann. Diallogit; Haidinger.

Rhombohedral. 100,111 = 43° 28′·5.

o 111, *a* $01\bar{1}$, *r* 100, *e* 011.

ao	90°	0′	*rr′*	73°	9′	
aa′	60	0	*eo*	25	23	(figs. 557, 578, 586, 580.)
ro	43	29	*ee′*	43	35	

Form and combinations. *r*, *ro*, *re*, *oa*. The faces *r* smooth, but curved; *e*, striated parallel to the intersections with *r*; *o*, convex, drusy. Cleavage. *r*, perfect; *e*, faint traces. Fracture uneven, imperfect conchoidal. Translucent in a slight degree. Lustre vitreous, inclining to pearly. Pale rose-red... flesh-red. Streak white. Brittle. H = 3·5...4·5. G = 3·43...3·63.

Decrepitates when heated. Before the blowpipe grows black, but is infusible. With borax in the outer flame forms a violet-blue glass. Soluble slowly in cold hydrochloric acid, quickly and with a brisk effervescence when heated.

$\dot{\mathrm{Mn}}\ddot{\mathrm{C}}$, carbonic acid 38·22, protoxide of manganese 61·78.

Analyses of diallogite *a* from Kapnik, *b* from Freiberg, both by Berthier, *c* from Nagyag, *d* from Kapnik, *e* from Freiberg by Stromeyer, *f* from Voigtsberg in Saxony by Kersten :—

	a	*b*	*c*	*d*	*e*	*f*
Carb. protox. mang. .	90·5	82·2	86·64	89·91	73·70	81·42
Carb. lime	9·5	8·9	10·58	6·05	13·08	10·31
Carb. magnesia . . .	—	1·6	2·43	3·30	7·26	4·28
Carb. protox. iron . .	—	7·3	—	—	5·76	3·10
Water	—	—	0·31	0·44	0·05	0·33

In attached crystals, globular, reniform, crystalline or radiating, columnar and compact masses.

Is found in veins in gneiss and porphyry at Freiberg in Saxony, Schemnitz, Kapnik in Hungary, Nagyag in Transylvania, Ihlefeld in the Harz ; in beds of hematite at Gonzen near Sargans in Switzerland, and Schebenholz not far from Elbingerode in the Harz, Glandree in the county of Clare in Ireland.

415. CALAMINE.—Carbonate of zinc ; Phillips. Zinc carbonaté ; Hauy. Rhomboedrischer Zink-Baryt ; Mohs. Galmei ; Hausmann. Smithsonit ; Haidinger.

Rhombohedral. 100,111 = 42° 57′·3.

o 111, *a* $01\bar{1}$, *r* 100, *e* 011, *f* $\bar{1}11$, *m* $3\bar{1}\bar{1}$, χ $\bar{4}33$, *s* $\bar{3}22$.

ao	90°	0′	*rr′*	72°	20′	χo	72°	56′
aa′	60	0	*fo*	61	46	$\chi\chi'$	111	46
eo	24	58	*ff′*	99	27	*so*	77	53
ee′	42	53	*mo*	74	58	*ss′*	115	43
ro	42	57	*mm′*	113	32			

FIG. 591.

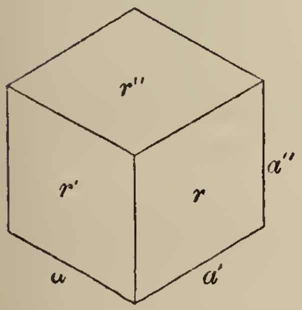


FIG. 592.

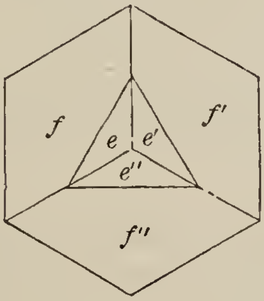
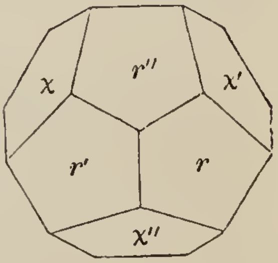


FIG. 593.



See also figs. 578, 580, 582, 581.

Forms and combinations. *r*, *m*, *ra*, *re*, *r*χ, *rs*, *ef*, *orm*, *ram*, *raf*. The faces *r* usually curved, frequently rough. Cleavage. *r*, perfect. Fracture uneven, imperfect conchoidal. Semi-transparent...translucent. Lustre vitreous, inclining to pearly.

Colourless, white, grey, green, brown. Streak white. Brittle. H = 5·0. G = 4·34...4·45.

Infusible before the blowpipe. On charcoal deposits a sublimate which is yellow while hot, but becomes white on cooling. The varieties containing cadmium in the inner flame deposit a sublimate surrounded by a red ring. With solution of cobalt becomes green. Soluble with effervescence in hydrochloric acid. Soluble in caustic potash.

$\dot{Z}n\ddot{C}$, carbonic acid 35·18, oxide of zinc 64·82.

Analyses of calamine *a* from Somersetshire, *b* from Derbyshire, both by Smithson, *c* from Nertschinsk, *d* from Altenberg, *e* from Brilon, all by Karsten, *f* from Taina in Siberia by Berthier:—

	a	*b*	*c*	*d*	*e*	*f*
Carb. acid	35·2	34·8	35·61	35·35	35·12	35·0
Ox. zinc	64·8	65·2	57·76	64·53	64·36	60·7
Protox. mangan. . . .	—	—	6·62	—	—	—
Ox. lead	—	—	—	—	0·50	—
Protox. iron	—	—	—	—	—	4·3

Analyses of calamine *g* from Altenberg in yellowish-white crystals, G = 4·20, from Nirm, *h* light green crystals, G = 4·03, *i* dark green crystals, G = 3·98, by Monheim, *k* from Nertschinsk by v. Kobell:—

	g	*h*	*i*	*k*
Carb. ox. zinc	84·92	85·78	74·42	96·00
Carb. protox. iron . . .	1·58	2·24	3·20	2·03
Carb. protox. mangan. . .	6·80	7·62	14·98	—
Carb. ox. lead	—	—	—	1·12
Carb. lime	1·58	0·98	1·68	—
Carb. magnesia	2·84	4·44	3·88	—
Silicate zinc	1·85	—	—	—
Silica	—	0·09	0·20	—
Volatile	—	—	0·56	—

In small attached crystals with obtuse rounded edges; in reniform, botryoidal, fibrous and granular masses; pseudomorphous after calcite.

Calamine occurs in beds and veins with smithsonite, galena, blende, in the crystalline slates, transition rocks, the coal formation, the Muschelkalk and oolite formations. It is found at Altenberg and Nirm near Aix la Chapelle, at Iserlohn and Brilon in Westphalia, near Tarnowitz in Silesia, at Raibel and Bleiberg in Carinthia, in the Banat, at Miedziana Gora in Poland, Dognazka, Rezbanya and Saska in Hungary, Kucsaina in Servia, Tschairski in the Altai, Nertschinsk and Nischne-

Tagilsk in Siberia, Chessy in France, in Belgium, Jefferson County and many other places in the United States, Wanlockhead and Leadhills in Scotland, the Mendip Hills in Somersetshire, Matlock in Derbyshire, Alston Moor in Cumberland.

416. SELBITE.—Carbonate of silver; Phillips. Argent carbonaté; Hauy. Grausilber; Hausmann. Selbite; Haidinger.

Amorphous. Fracture uneven...earthy. Opaque. Dull. Grey of various shades. Streak grey, shining. Soft. Sectile. Before the blowpipe on charcoal easily reducible to silver. Soluble with effervescence in nitric acid.

Analysis of selbite from Altwolfach by Selb:—

Carbonic acid	12·0
Silver	72·5
Carbonate of oxide of antimony with some $\dot{Cu}$	15·5

Was found in small quantity in St. Wenzel's mine near Altwolfach in the Black Forest; occurs more abundantly at Real de Catorce in Mexico, accompanied by linarite.

417. AGNESITE.—Bismuth carbonaté; Dufrénoy. Bismutit; Hausmann, Haidinger.

Amorphous. Fracture conchoidal...uneven, earthy. Opaque ...translucent on the edges. Lustre vitreous...dull. Green and yellow of various shades. Streak greenish-grey or white. H = 4·0...4·5. G = 6·909.

In the matrass yields a little water, decrepitates and becomes grey. Before the blowpipe melts very easily and is reduced with effervescence to a metallic bead, which on continuing the blast deposits a sublimate of oxide of bismuth on the charcoal. Soluble with effervescence in hydrochloric acid.

Consists, according to Plattner, principally of carbonate of oxide of bismuth, mixed with oxide of copper, iron and sulphuric acid.

Occurs massive, disseminated, investing other minerals, and in acicular pseudomorphous crystals.

Is found in the Arme Hülfe mine at Ullersreuth, Schneeberg and Johann-Georgenstadt, St. Agnes in Cornwall.

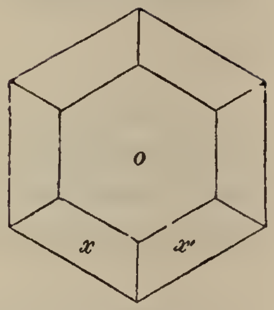
418. PARISITE.—Parisit; Hausmann.

Rhombohedral. 100,111 = 81° 20′.

o 111, *x* $13\bar{1}$.

xo	82° 29′
xx′	59 26

FIG. 594.



Cleavage. *o*, very perfect; *r*, very imperfect. Fracture small conchoidal. Lustre vitreous, *o* pearly. Brownish-yellow, inclining to red. Streak yellowish-white. H = 4·5. G = 4·350.

In the matrass yields water and carbonic acid, becomes cinnamon-brown, and friable. Before the blowpipe phosphoresces, but is infusible. With borax forms a yellow bead, which becomes colourless on cooling. Difficultly soluble, with effervescence, in hydrochloric acid.

Analysis by Bunsen:—

Carbonic acid	23·51
Cerium, lanthanium, didymium	50·78
Calcium	8·29
Fluorine	5·49
Oxygen	9·55
Water	2·38

Is found in crystals in the emerald mines of Muzo in New Grenada.

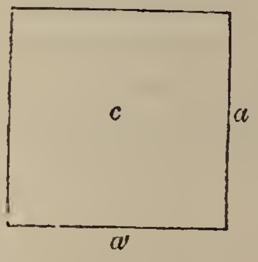
419. LANTHANITE.—Carbonate of cerium; Phillips. Cerium carbonaté; Dufrénoy. Lanthanit; Hausmann, Haidinger.

Pyramidal.

a 100, *c* 001.

aa′	90° 0′
ac	90 0

FIG. 595.



Cleavage. *c*, perfect. Lustre pearly. White passing into grey, yellow. Streak white. H = 2·5...3.

Before the blowpipe takes a brownish-yellow colour. Soluble in acids with effervescence.

$\dot{\mathrm{L}}\mathrm{a}^3\ddot{\mathrm{C}} + 3\dot{\mathrm{H}}$, carbonic acid 10·13, oxide of lanthanium 77·42, water 12·45.

According to Hisinger and Mosander, consists of:—

Carbonic acid	10·8
Oxide of lanthanium with traces of $\dot{\mathrm{C}}\mathrm{e}$	75·7
Water	13·5

Is found in small square tabular crystals, in granular masses, and investing other minerals, with cererite, at Riddarhytta in Sweden.

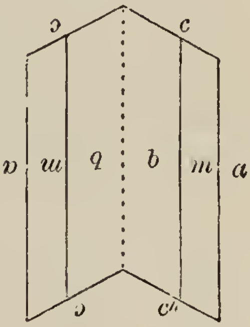
420. MALACHITE.—Green carbonate of copper; Phillips. Malachite; Beudant. Hemiprismatischer Habronem-Malachit; Mohs. Malachit; Hausmann, Haidinger.

Oblique.

a 100, *b* 010, *c* 001, *m* 110.

cb	90°	0′	*ma*	36°	20′
ab	90	0	*mb*	53	40
ca	61	45	*cm*	67	35

FIG. 596.



The faces *c* rough; *a* sometimes striated parallel to its intersection with *m*. Twins. Twin-face *a*. $c\text{ɔ} = 56° 30'$, $mu = 107° 20'$. Cleavage. *c*, *b*, very perfect, the former more easily obtained. Fracture conchoidal...uneven. Translucent...translucent on the edges. Lustre adamantine, inclining to vitreous. Emerald-green, verdigris-green. Streak verdigris-green. Brittle. H = 3·5...4·0. G = 3·71...4·01.

In the matrass decrepitates, yields water, and turns black. Before the blowpipe on charcoal is reduced to a bead of pure copper. With borax in the outer flame forms a green glass, in the inner flame a colourless glass, which on cooling becomes red and opaque. Soluble with effervescence in nitric acid, also in ammonia.

$\dot{\mathrm{C}}\mathrm{u}\ddot{\mathrm{C}} + \dot{\mathrm{C}}\mathrm{u}\dot{\mathrm{H}}$, carbonic acid 19·93, oxide of copper 71·91, water 8·16.

Analyses of crystallized malachite from Chessy *a* by Vauquelin, *b* by Phillips, *c* of compact malachite from Turjinsk by Klaproth:—

	a	*b*	*c*
Carbonic acid	21·25	18·5	18·0
Oxide of copper	70·10	72·2	70·5
Water	8·75	9·3	11·5

In twin crystals, globular, reniform and stalactitic masses, exhibiting a fibrous composition, earthy, pseudomorphous after calcite, cuprite, chessylite. It appears to be produced by the decomposition of other ores of copper.

Is found in the copper mines of Chessy near Lyons, Linares in Spain, Siegen and Rheinbreitenbach in Prussia, Saalfeld in Thuringia, Falkenstein near Schwatz in the Tyrol, Szaska and Moldawa in the Banat, Miedziana Gora in Poland, in the mines of Werchoturi, Gumeschewkoi, Turjinsk and Nischne-Tagilsk in Siberia, in Cornwall, Wales, Ireland, Shetland.

421. CHESSYLITE.—Blue carbonate of copper; Phillips. Azurite; Beudant. Hemiprismatischer Lazur-Malachit; Mohs. Kupferlasur; Hausmann. Lasur; Haidinger.

Oblique. 101,100 = 45° 4′; 111,010 = 58° 3′·5; 101,001 = 47° 17′.

a 100, *b* 010, *c* 001, *p* 021, *f* 011, *l* 023, *q* 025, *r* 108, μ 105, *n* 012, θ 101, η 302, *v* 201, ψ 301, ϕ $\bar{2}01$, ς $\bar{1}01$, ζ $\bar{1}02$, *w* 120, *m* 110, *i* 320, *g* 210, *x* 111, *s* $\bar{1}11$, *y* 211, *z* 411, *u* 223, *k* 221, *h* $\bar{2}21$, *t* 125, *e* 245, *d* 243, γ $\bar{1}21$, δ $\bar{2}43$, *o* 241, ρ 134.

ab	90°	0′	*yy′*	137°	39′	*uc*	43°	2′
bc	90	0	*oo′*	65	40	*xc*	54	52
ψ*a*	18	1	*zz′*	156	33	*kc*	71	25
va	26	9	*uu′*	127	39	*mc*	91	48
η*a*	33	24	*dd′*	90	59	*hc*	68	14
θ*a*	45	4	*ee′*	113	11	*sc*	52	32
na	64	25	*tt′*	143	31	*yc*	67	56
μ*a*	80	32	δδ′	93	12	*zc*	78	57
ra	84	55	*ss′*	118	16	*tc*	28	58
ca	92	21	*hh′*	106	14	*ec*	39	41
ζ*a*	119	16	γγ′	79	51	*dc*	54	27
ς*a*	137	13	ρρ′	114	24	*oc*	77	23
φ*a*	154	44	*za*	17	54	*wc*	91	12
qq′	141	16	*ya*	33	9	γ*c*	117	3
ll′	119	15	*xa*	53	8	δ*c*	127	5
ff′	97	22	*fa*	91	46	*xv*	36	38
pp′	59	14	*sa*	129	4	*dv*	52	21
ww′	61	10	*ka*	44	47	*pv*	78	30
mm′	99	32	*pa*	91	10	*mv*	46	45
ii′	121	10	γ*a*	118	7	*uv*	36	49
gg′	134	8	*ha*	136	45	*ev*	49	54
xx′	116	7	*ta*	70	32	*fv*	69	38
kk′	104	26	*qa*	92	13	δ*v*	94	45

hv	117°	7′	*xφ*	106°	37′	*δφ*	50°	18′
gv	34	14	*sφ*	35	3	*pφ*	78	30
						oφ	122	50
						mφ	133	15
						ρθ	44	55
						fθ	59	22
						mθ	57	11

FIG. 597.

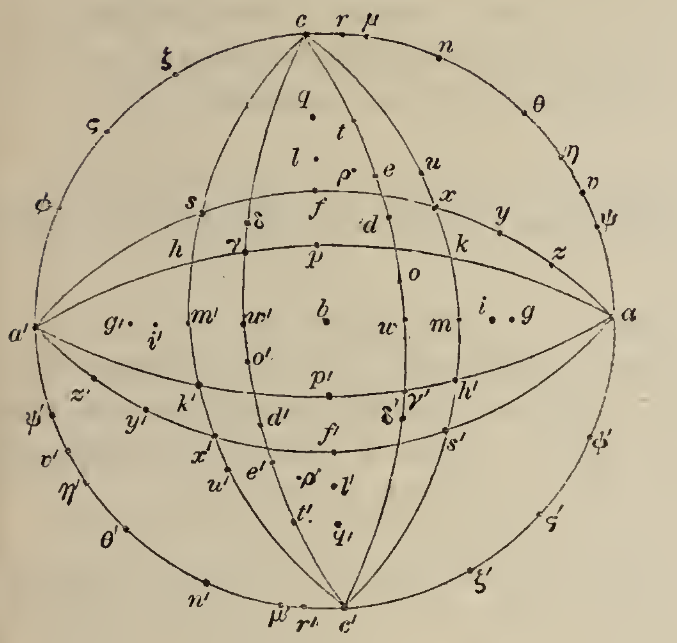
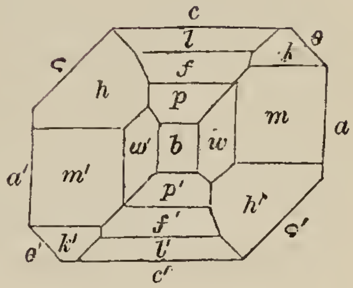


FIG. 598.



Combinations. *acd..m.θ.ς.h.φ.p*, *mc..h.x.u.θ.f.q*, *xhc..m.θ.fq*, *amc..x.h.φθ.r.p.q*, *amch.θς.dfq.xγ.v.lθ*, *axmθchdq.gefp*, *aθcςgmxuhodepfg*, *avθrcςmpbkxhsdopq*, *amchlpφ.f*, *amchlpfφρςμθηψ*, *amchlpfθςo.kφsηv*. The faces *c* striated parallel to their intersections with *f*; *a* sometimes striated parallel to their intersections with *c*; *v*, *u*, rough; *b*, sometimes concave. Twins. Twin-face *θ*. Cleavage. *p*, perfect, but interrupted; *a*, less distinct; *m*, traces. Fracture conchoidal. Transparent…translucent on the edges. Lustre vitreous, inclining to adamantine. Blue. Streak smalt-blue. Brittle. H = 3·5…4·0. G = 3·766…3·831.

In the matrass becomes black and yields water. Before the blowpipe on charcoal is reduced to a bead of copper. With borax forms a blue glass. Soluble with effervescence in nitric acid and in sulphuric acid. Soluble also in ammonia.

$2\dot{C}u\ddot{C} + \dot{C}u\dot{H}$, carbonic acid 25·58, oxide of copper 69·19, water 5·23.

Analyses of chessylite from the Ural *a* by Klaproth, from Chessy *b* by Phillips, *c* by Vauquelin:—

	a	*b*	*c*
Carbonic acid	24	25·46	25·0
Oxide of copper	70	69·08	68·5
Water	6	5·46	6·5

In attached crystals, in botryoidal, stalactitic and compact masses, earthy. It probably is the result of the decomposition of other ores of copper.

Is found at Chessy near Lyons, Solotuschensk, Nikolajewsk, Schlangenberg and Sewersk in the Altai, Moldawa, Saska and Dognazka in the Banat, Maidanpek in Servia, Miedziana Gora in Poland, Schwatz in the Tyrol, Zinnwald in Bohemia, Linares in Spain, Wheal Buller near Redruth in Cornwall, Alston Moor in Cumberland, Wanlockhead in Scotland, Thuringia, Hessia, Wirtemberg, Silesia, Chile.

422. BURATITE.—Aurichalcit; Dufrénoy, Hausmann, Haidinger.

Translucent. Lustre pearly. Verdigris-green. H = 2·0.
In the matrass yields water and grows black. Before the blowpipe, in the inner flame, deposits a sublimate of zinc on the charcoal. With soda and borax yields a globule of copper. Easily soluble with effervescence in hydrochloric acid.

$\dot{Z}n^3\ddot{C} + \dot{C}u^2\ddot{C} + \dot{H}^3$, carbonic acid 16·19, oxide of copper 29·17, oxide of zinc 44·71, water 9·93.

Analyses of buratite (orichalcite) from Loktefsk *a*, *b* by Böttger, *c* from Loktefsk, *d* from Chessy, G = 3·32, both by Delesse, *e* of a very small quantity from Matlock by Connell :—

	a	*b*	*c*	*d*	*e*
Carb. acid	16·06	16·08	21·45	20·03	27·5
Water	9·95	9·93	8·45	7·62	
Ox. copper	28·19	28·36	29·46	29·00	32·5
Ox. zinc	45·84	45·62	32·02	41·19	42·7
Lime	—	—	8·62	2·16	trace

Is found in acicular crystals and columnar masses, at Loktewsk and some other places in the Ural, Chessy in France. Substances resembling buratite are found in the maremma of Volterra in Tuscany, in Framont, in the Tyrol, and in Siberia.

423. HYDROMAGNESITE.—Hydromagnesit; Hausmann, Haidinger.

Faintly translucent. Dull. H = 2·5.
Infusible before the blowpipe. Easily soluble, with effervescence, in hydrochloric acid.

$3\dot{M}g\ddot{C} + \dot{M}g\dot{H}^4$, carbonic acid 35·86, magnesia 44·68, water 19·46.

Analyses of hydromagnesite *a* from Hoboken by Trolle-Wachtmeister, *b* from Kumi by v. Kobell :—

	a	b
Carbonic acid	36·82	36·00
Magnesia	42·41	43·96
Water	18·53	19·68
Silica	0·57	0·36
Red oxide of iron	0·27	—
Stony matter	1·39	—

Is found in earthy masses in serpentine at Kumi in Negroponte, Hoboken in New Jersey, and several places in New York, in the island of Unst, and, it is said, in the East Indies.

424. GAYLUSSITE.—Gaylussite; Beudant. Hemiprismatisches Kuphon-Haloid; Mohs. Gaylussit; Hausmann, Haidinger.

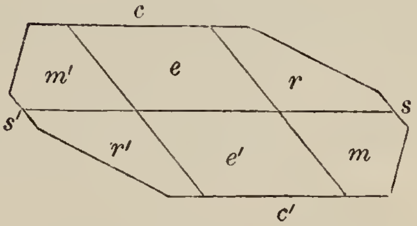
Oblique. 101,100 = 73° 50′; 111,010 = 55° 15′; 101,001 = 27° 43′.

a 100, *c* 001, *e* 021, *s* 201, *m* 110, *r* 111. *a* is common to the zones *sc*, *mm′*.

sc	49°	39′
sa	51	54
ac	78	27
ec	54	45
ee′	70	30
ma	55	35
mm′	68	50
rr′	110	30
rc	43	21
mc	96	30

rs	40°	39′
es	68	59
ms	70	33

FIG. 599.



Combinations. *crem*, *crea*, *crsem*. The faces *e* striated parallel to their intersections with *r*. Cleavage. *m*, distinct; *c*, less distinct. Fracture conchoidal...uneven. Transparent...translucent. Lustre vitreous. Colourless, white, grey, yellow. Streak white. Brittle. H = 2·5. G = 1·928...1·950.

In the matrass decrepitates, yields water, and becomes opaque. Before the blowpipe melts easily into an opaque alkaline bead. When reduced to powder slightly soluble in water. After ignition water dissolves the carbonate of soda entirely, leaving the carbonate of lime undissolved. Easily soluble, with effervescence, in nitric or hydrochloric acid.

$\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{C}} + \dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}} + 5\dot{\mathrm{H}}$, carbonate of soda 35·9, carbonate of lime 33·8, water 30·3.

Analysis by Boussingault:—

Carbonate of soda	34·5
Carbonate of lime	33·6
Water	30·4
Clay	1·5

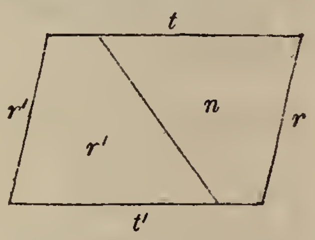
In isolated crystals imbedded in a stratum of clay, covering a bed of carbonate of soda, at Lagunilla near Merida in Columbia.

425. **TRONA.**—Trona; Phillips, Dufrénoy. Prismatoidisches Trona-Salz; Mohs. Trona; Hausmann, Haidinger.

Oblique.

rt	103°	15′
tr′	76	45
nn′	47	30
tn	76	15
rn	74	49

FIG. 600.



The faces *t* are striated parallel to their intersections with *r*. Cleavage. *r*, perfect; *n* and *t*, traces. Fracture uneven…conchoidal. Transparent…translucent. Lustre vitreous. Colourless, white, when impure yellowish-grey. Streak white. Brittle. H = 2·5. G = 2·112. Taste alkaline.

Does not effloresce when exposed to the air. Before the blowpipe melts very readily, imparting a yellow colour to the flame. Easily soluble in water.

$\dot{\mathrm{N}}\mathrm{a}^2\ddot{\mathrm{C}}^3 + 4\dot{\mathrm{H}}$, carbonic acid 40·26, soda 37·78, water 21·96.

Analyses of trona from Fezzan *a* by Klaproth, *b* by Beudant, *c* from Lagunilla by Boussingault:—

	a	*b*	*c*
Carbonic acid	38·0	40·13	39·00
Soda	37·0	38·62	41·22
Water	22·5	21·24	18·80
Sulphate of soda	2·5	—	—

Is found in crystals and granular masses on the banks of the natron lakes in Egypt, in Suckena in Fezzan, at Lagunilla not far from Merida in Columbia under a stratum of clay.

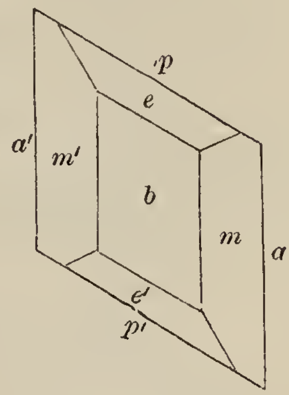
426. **NATRON.**—Carbonate of soda; Phillips. Soude carbonatée; Dufrénoy. Hemiprismatisches Natron-Salz; Mohs. Soda; Hausmann. Natron; Haidinger.

Oblique. 101,100 = 58° 52′; 111,010 = 54° 19′; 101,001 = 28° 8′.

a 100, *b* 010, *u* 011, *p* 101, *s* $\bar{1}$01, *m* 110, *e* 121. *s* is common to the zones *ap*, *me*; *u* is common to the zones *me*, *pm′*.

ab	90°	0′	*uu′*	110°	5′
pb	90	0	*mm′*	76	28
pa	58	52	*ee′*	79	41
sp	57	40	*pm*	71	25
sa′	63	28	*ea*	72	49

FIG. 601.



Combinations. *em*, *emb*, *eusmb*, *pemab*. Twins. Twin-face *p*. Cleavage. *p*, distinct; *b*, imperfect; *m*, traces. Fracture conchoidal. Transparent...semi-transparent. Lustre vitreous. Colourless, white; yellow or grey when impure. Streak white. Sectile. H = 1·0...1·5. G = 1·423. Taste alkaline, pungent.

Effloresces when exposed to the air. In the matrass melts at a low heat. Before the blowpipe with silica fuses with effervescence, imparting a yellow colour to the flame. Readily soluble in water. The solution reddens turmeric paper, and turns reddened litmus blue. Effervesces with acids.

$\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{C}} + 10\dot{\mathrm{H}}$, carbonic acid 15·39, soda 21·66, water 62·95.

Is found abundantly as an efflorescence in the plain of Debreczin in Hungary, in the Asiatic steppes, on rocks at Bilin in Bohemia; among volcanic products on Vesuvius, Ætna, Pico de Teyde in Teneriffe, Guadaloupe, on lavas; dissolved in the soda lakes of Egypt, in the springs of Carlsbad and Rykum.

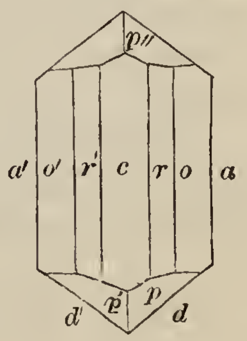
427. THERMONATRITE.—Soude carbonatée prismatique; Dufrénoy. Prismatisches Natron-Salz; Mohs. Thermonitrit; Hausmann. Thermonatrit; Haidinger.

Prismatic. 011,010 = 18° 7′; 101,001 = 48° 5′; 110,100 = 69° 59′.

a 100, *c* 001, *o* 101, *r* 102, *d* 210, *p* 111.

ac	90°	0′	*pp′*	38°	12′
oo′	96	10	*pp″*	127	51
rr′	58	14	*p′p″*	145	52
dd′	72	10			

FIG. 602.



Combinations. *cda*, *oda*, *opda*, *cropda*. The faces *a* very bright. Cleavage. *a*, traces. Fracture conchoidal. Transparent...translucent.

Lustre vitreous. Colourless, white...yellowish. Streak white. Sectile. H = 1·5. G = 1·5...1·6. Taste pungent, alkaline.

It does not melt in the matrass at a very low heat; in other respects its reactions are the same as those of natron. It does not effloresce so readily as natron.

$\dot{Na}\ddot{C} + \dot{H}$, carbonic acid 35·50, soda 49·98, water 14·52.

Analyses of thermonatrite from Debreczin and Vesuvius by Beudant:—

Carbonic acid	35·1	33·9
Soda	50·2	49·2
Water	14·7	14·7
Chloride of sodium	—	2·7

Is found associated with natron, which, in efflorescing, becomes thermonatrite. A solution of carbonate of soda, saturated at from 25° C to 37° C, and permitted to cool slowly, deposits crystals of thermonatrite, while a less saturated solution at a lower temperature yields crystals of natron. In the carbonate of soda of commerce both species are mingled together. The crystals of thermonatrite occur in drusy cavities in the natron, and remain bright while the natron effloresces.

NITRATES.

428. NITRATINE.—Nitrate of soda; Phillips. Nitrate de soude; Beudant. Rhomboedrisches Nitrum-Salz; Mohs. Natronsalpeter; Hausmann. Nitratin; Haidinger.

Rhombohedral. 100,111 = 43° 40′.

r 100.

rr′ 73° 27′ (fig. 578.)

An increase of temperature of 100 C causes *rr′* to increase about 27′. Cleavage. *r*, very perfect. Fracture conchoidal, seldom perceptible. Transparent...translucent. Lustre vitreous. Colourless, white, grey, brown. Streak white. Moderately sectile. H = 1·5...2·0. G = 2·0964. Taste bitter and cooling.

Deflagrates on burning charcoal. Before the blowpipe on platinum wire melts easily and imparts a yellow colour to the flame. Is soluble in thrice its weight of water at 15° C.

$\dot{Na}\overset{.....}{N}$, nitric acid 63·56, soda 36·44.

Analyses of nitratine from the desert of Atacama by Le Canu, from Tarapaca by Hofstetter:—

Nitrate of soda	96·70	94·29
Chloride of sodium	1·30	1·99
Nitrate of potash	—	0·43
Sulphate of potash	—	0·24
Nitrate of magnesia . . .	—	0·86
Water	2·00	1·99
Remainder	—	0·20

Is found in crystals and crystalline masses, in the district of Tarapaca in Peru, near the frontier of Chile, in extensive beds several feet thick, with clay and sand.

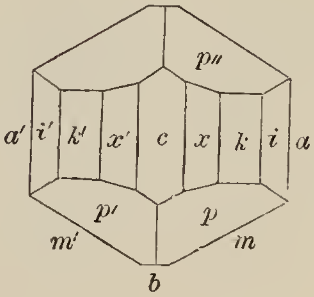
429. NITRE.—Nitrate of potash; Phillips. Potasse nitratée; Hauy. Prismatisches Nitrum-Salz; Mohs. Kalisalpeter; Hausmann. Salpeter; Haidinger.

Prismatic. 011,010=40° 8′; 101,001=35° 1′·7; 110,100=59° 25′.

a 100, *b* 010, *c* 001, *i* 201, *k* 101, *x* 102, *m* 110, *p* 111.

bc	90°	0′	*ii′*	109°	0′
ca	90	0	*mm′*	61	10
ab	90	0	*pp′*	48	38
xx′	38	38	*pp″*	88	20
kk′	70	3	*p′p″*	108	3

FIG. 603.



These angles were determined at a temperature of 19° C. An increase of temperature of 100° C increases *kk′* by about 44′. *mm′* does not appear to change. Combinations. *kma*, *ckma*, *pxkma*, *xkma*, *xkima*. Twins. Twin-face *m*. Cleavage. *k*, perfect; *a*, less perfect; *m*, imperfect. Fracture conchoidal. Transparent...translucent. Lustre vitreous. The indices of refraction, for the brightest rays of the spectrum, of light in planes parallel to *a*, *b*, *c* respectively, and polarized in those planes, are 1·5052, 1·5046, 1·333. The optic axes lie in a plane parallel to *b*. When seen in air through the faces *c*, they appear to make angles of 4° 20′ with a normal to *c*. Colourless, white, greyish, yellowish. Streak white. Sectile. H = 2·0. G = 1·933. Taste saline and cooling.

Melts at 350° C. Before the blowpipe on platinum wire imparts a violet colour to the flame. It deflagrates when thrown on red-hot charcoal. One part is soluble in 7·5 of water at 0° C; in 3·45 parts at 18°; in 1·34 parts at 45° C. It is permanent in the air.

$\dot{K}\overset{\cdot\cdot\cdot\cdot\cdot}{N}$, nitric acid 53·41, potash 46·59.

Nitre appears as an efflorescence on the surface of the earth, on limestone, marl, chalk, also in caverns in limestone. It is easily produced under favourable circumstances, especially by the action of atmospheric air on decaying animal and vegetable matter mingled with calcareous soil or wood ashes. It is found in large quantities in Hungary, Podolia, the Ukraine, in Spain, especially in Aragon, Italy, Evreux in France, Arabia, the East Indies, Calabria, Ceylon, Kentucky, Virginia, near Tejuco in the Brazils.

BORATES.

430. BORACITE.—Boracite; Phillips. Magnésie boratée; Hauy. Tetraedrischer Boracit; Mohs. Boracit; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *n* 211, *v* 531. The forms *o*, *n*, *v* are hemihedral with inclined faces.

aa′	90°	0′	*no*	19°	28′
oo′	70	32	*nd″*	30	0
oo,,	109	28	*nd*	54	44
oa	54	44	*va′*	32	19
dd′	60	0	*vo*	28	35
da′	45	0	*vd*	17	1
do	35	16	*vv′*	27	40
na	35	16			

FIG. 604.

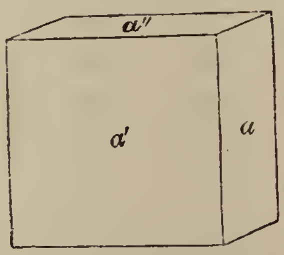


FIG. 605.

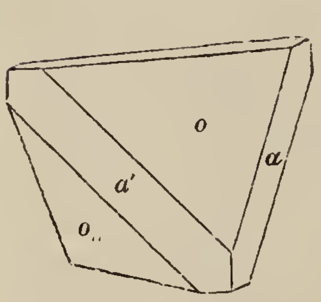


FIG. 606.

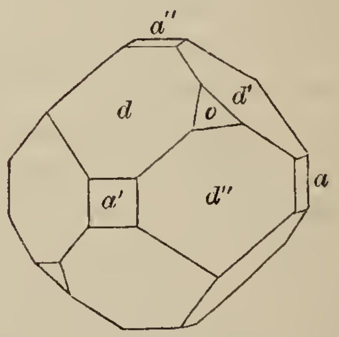
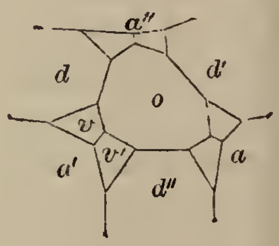
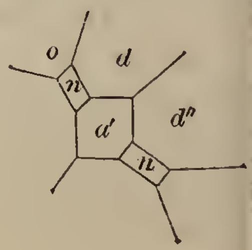


FIG. 607.



Form and combinations. *a*, *ad*, *ao*ˋ, *do*ˋ, *oad*, *ado*ˋ, *ado*ˋ*n*′, *aodv*ˋ, *ado*ˋ*o*′*n*ˋ, *ado*ˋ*n*′*v*ˋ. When the two half forms *o*′, *o*ˋ occur together, the faces of one are usually smaller than those of the other; also, the faces of one half form are bright, and those of the other uneven and dull. Cleavage. *o*, very imperfect; *o*′, fre-

FIG. 608.



quently more distinct than *o*‵; *a*, traces. Fracture conchoidal ...uneven. Transparent...translucent on the edges. Lustre vitreous, inclining to adamantine. $\mu = 1{\cdot}701$. Colourless, white, inclining to grey, yellow, green, brown. Streak white. H = 7·0. G = 2·83...2·98. Pyroelectric. The angles of *a*, which are truncated by the bright faces of *o*, are the antilogous poles; the angles truncated by the rough faces of *o*, the analogous poles.

Before the blowpipe intumesces and melts with difficulty into a bead, which on cooling becomes a white, opaque aggregation of acicular crystals. With fluor and bisulphate of potash imparts a green colour to the flame. With borax and salt of phosphorus forms a transparent glass. In powder perfectly soluble in hydrochloric and nitric acids.

$\dot{\mathrm{M}}\mathrm{g}^3\dddot{\mathrm{B}}^4$, boracic acid 69·30, magnesia 30·70.

Analyses of boracite from Lüneburg *a* by Arfvedson, *b*, *c* by Rammelsberg :—

	a	*b*	*c*
Boracic acid	69·7	69·25	68·88
Magnesia	30·3	30·75	31·12

Is found in small crystals imbedded in gypsum near Lüneburg in Brunswick, and at Segeberg in Holstein. A fibrous variety was found in gypsum near Luneville in France. A compact variety, H = 4·5, was found in boring for rock salt near Stassfurth. According to Karsten it consists of:—boracic acid 69·49, magnesia 29·48, carbonate of protoxide of iron 1·03.

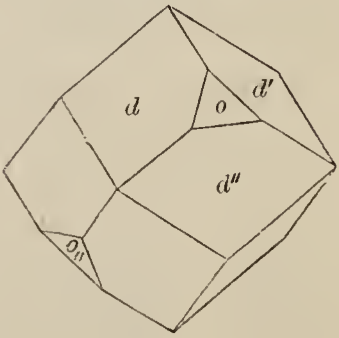
431. RHODIZITE. — Rhodizite; Dufrénoy. Rhodicit; Hausmann. Rhodizit; Haidinger.

Cubic.

o 111, *d* 011. The form *o* is hemihedral with inclined faces.

$oo_{,,}$	109°	28′
dd'	60	0
do	35	16

FIG. 609.



The faces *o* bright and even; *d* sometimes curved. Cleavage not observable. More or less translucent. Lustre vitreous, inclining to adamantine. White, inclining to yellow or grey. H above 8.

G = 3·416. Pyroelectric, the faces *o* being the antilogous poles, and the opposite angles the analogous poles.

Fusible with great difficulty before the blowpipe. At first it imparts a green, and afterwards a red colour to the flame. A thin fragment on platinum wire melts into a white enamel, which intumesces and shines with a yellowish-red light. With borax and salt of phosphorus forms a clear glass.

$\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{B}}^4$?

Is found, in small attached and imbedded crystals, at Sarapulsk, and Schaitansk near Mursinsk in the Ural, with red tourmaline and quartz.

HYDROUS BORATES.

432. HYDROBORACITE.

—Hydroboracite; Dufrénoy. Hydroboracit; Mohs, Hausmann, Haidinger.

In thin leaves translucent. White, sometimes coloured red by red oxide of iron. H = 2·0. G = 1·9.

In the matrass yields water. Before the blowpipe melts easily into a colourless clear glass, imparting a green colour to the flame. Soluble in heated nitric and hydrochloric acids. Slightly soluble in water.

$\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{B}}^4 + \dot{\mathrm{M}}\mathrm{g}^3\dddot{\mathrm{B}}^4 + 18\dot{\mathrm{H}}$, boracic acid 47·43, magnesia 10·53, lime 14·52, water 27·52.

Analyses by Hess:—

Boracic acid	49·22	49·92
Magnesia	10·71	10·43
Lime	13·74	13·30
Water	26·33	26·33

Was found in fibrous masses in the Caucasus.

433. TINCAL.

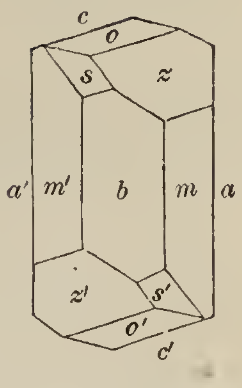
—Borate of soda; Phillips. Soude boratée; Hauy. Prismatisches Borax-Salz; Mohs. Tinkal; Hausmann. Borax; Haidinger.

Oblique. 101,100 = 52° 33′; 111,010 = 48° 20′; 101,001 = 54° 2′.

a 100, *b* 010, *c* 001, *s* 021, *m* 110, *z* 111, *o* 112.

bc	90°	0′	*mm′*	87°	0′	*oc*	40°	30′
ab	90	0	*zz′*	96	40	*zc*	64	7
ca	106	35	*oo′*	122	34	*mc*	101	20
ss′	49	43						

FIG. 610.



Combinations. *cma*, *cmab*, *coab*, *cozmab*, *cozmsab*. The faces *o*, *z*, *m* are striated parallel to their intersections with each other. Cleavage. *a*, perfect; *m*, less perfect; *b*, traces. Fracture conchoidal. Transparent...translucent. Lustre resinous. R = 1·47. The optic axes for different colours do not lie in the same plane. The mean directions of the optic axes, seen in air through the faces *b*, make angles of about 29° 30′ with a normal to *b*. A perpendicular to the plane in which they lie makes angles of nearly 55° and 18° 25′ with normals to *a′*, *c* respectively. Colourless, white, inclining to grey, yellow, green. Streak white. Rather brittle. H = 2·0...2·5. G = 1·716. Taste alkaline, sweetish.

In the matrass yields water. Before the blowpipe intumesces and melts into a clear colourless bead, which when moistened with sulphuric acid, or mixed with fluor and bisulphate of potash, imparts a green colour to the flame. Soluble in 2 parts of boiling water, and in 12 of cold water.

$\dot{Na}\dddot{B}^2 + 10\dot{H}$, boracic acid 36·5, soda 16·4, water 47·1.

Is found on the shores of some lakes in Thibet, Nepaul, China, Ceylon, Escapa near Potosi in South America.

FLUORIDES, CHLORIDES, BROMIDES, IODIDES.

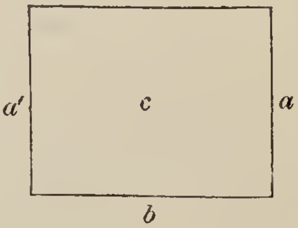
434. CRYOLITE.—Cryolite; Phillips, Dufrénoy. Prismatisches Kryon-Haloid; Mohs. Kryolith; Hausmann, Haidinger.

Prismatic.

a 100, *b* 010, *c* 001.

bc	90°	0′
ca	90	0
ab	90	0

FIG. 611.



Cleavage. *c*, tolerably perfect; *a*, *b* less distinct. Fracture uneven...imperfect conchoidal. Semi-transparent...translucent. Becomes more transparent after immersion in water. Lustre vitreous, on *c* pearly. R = 1·668...1·685. White, sometimes inclining to yellow, red or brown. Streak white. Brittle. H = 2·5...3·0. G = 2·953...2·963.

In the open tube yields vapours which corrode glass. Melts in the flame of a candle. Before the blowpipe fuses readily into a white enamel. Easily soluble in borax and salt of phosphorus. Completely soluble in concentrated sulphuric acid with disengagement of hydrofluoric acid.

$3NaF + AlF^3$, fluorine 54·05, sodium 32·92, aluminium 13·03.

From 100 parts of cryolite Berzelius and Chodnew obtained respectively:—

Alumina	24·40	24·83
Soda	44·25	43·89
Magnesia and protoxide of manganese .	—	0·83

Composition of cryolite from Greenland *a* deduced from the analysis by Berzelius, *b* of cryolite from Miask according to Durnew:—

	a	*b*
Fluorine	54·07	53·48
Sodium	32·93	32·31
Aluminium	13·00	13·41
Calcium	—	0·25
Oxides of iron and manganese . .	—	0·55

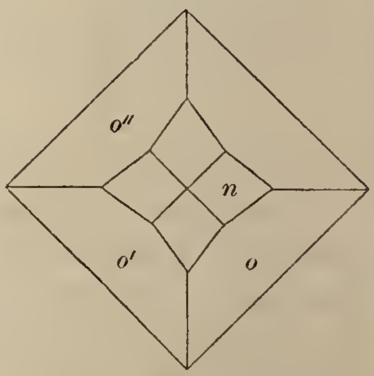
Is found in crystalline masses on the shore at Ivikaet, on the south side of Arksud-Fiord in West Greenland, in two thin beds in gneiss, in one of which the white variety occurs alone; in the other the coloured variety with galena, pyrite, quartz, felspar and chalybite, and with chiolite and chodnewite, in granite, at Miask in Siberia.

435. CHIOLITE.—Chiolite; Hermann.

Pyramidal. 101,001 = 47° 8′.

o 111.

FIG. 612.



oo′	72° 28′
oo″	113 26

Cleavage. *o* ? Transparent…translucent. Lustre resinous. Colourless, white. H = 4·0. G = 2·84…2·90, in powder.

Melts in a crucible over a spirit-lamp. In the open tube yields the vapour of hydrofluoric acid. Melts very easily before the blowpipe into a globule which becomes white on cooling. Imparts a yellow colour to the flame. Melted with borax yields a mass in which cubic crystals form as it cools. Is decomposed with effervescence by sulphuric acid.

$3\mathrm{NaF} + 2\mathrm{AlF}^3$, fluorine 57·48, sodium 23·83, aluminium 18·69.

Analyses of chiolite from Miask *a* by Hermann, *b*, *c*, *d* by Rammelsberg:—

	a	*b*	*c*	*d*
Fluorine	57·53	—	—	—
Sodium	23·78	24·69	24·56	22·91
Aluminium	18·69	18·02	17·72	19·59

Is found in crystals and granular masses, with topaz, fluor, phenakite, quartz and green felspar, in granite, at Miask.

436. CHODNEWITE.

G = 3·0...3·08. The other characters the same as those of chiolite.

$2\mathrm{NaF} + \mathrm{AlF}^3$, fluorine 55·85, sodium 27·80, aluminium 16·35.

Analyses of chodnewite from Miask, *a*, *b* by Chodnew, *c*, *d*, *e* by Rammelsberg:—

	a	*b*	*c*	*d*	*e*
Fluorine	53·61	—	—	—	—
Sodium	26·54	26·85	27·53	28·29	27·22
Potassium	0·59	—	—	—	—
Aluminium	16·43	16·54	—	15·40	16·11
Magnesium	0·93	—	—	—	—
Yttrium	1·04	—	—	—	—
Loss by ignition . . .	0·86	—	—	—	—

Is found with chiolite at Miask in Siberia.

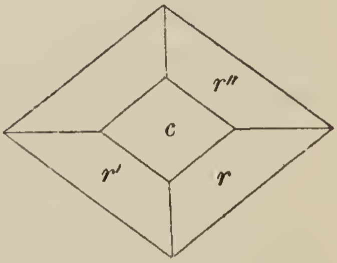
437. FLUELLITE.—Fluelite; Beudant. Fluellit; Mohs, Hausmann, Haidinger.

Prismatic. 011,010 = 22° 17′; 101,001 = 61° 58′; 110,100 = 52° 25′.

c 001, *r* 111.

rc	72° 0′	*rr″*	97° 48′
rr′	70 54	*r′r″*	144 0

FIG. 613.



Combination. *cr*. Translucent. White. According to Wollaston, contains fluorine and alumina.

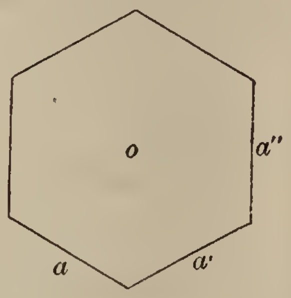
Was found in crystals, with wavellite and torberite, on quartz at Stenna Gwyn in Cornwall.

438. **FLUOCERITE.**—Neutral fluate of cerium; Phillips. Flucerine; Beudant. Neutrales Flusssaures Cerer; Mohs. Fluocerit; Hausmann, Haidinger.

Rhombohedral.

o 111, *a* $01\bar{1}$.

FIG. 614.



ao	90°	0′
aa′	60	0

Fracture uneven, splintery. Opaque, translucent on the edges. Lustre feeble. Pale red, yellowish. Streak yellowish-white. H = 4·0...5·0. G = 4·7.

In the matrass yields hydrofluoric acid and some water, and becomes white. In the open tube becomes dark yellow, and the hydrofluoric acid evolved corrodes the glass. Infusible before the blowpipe. In salt of phosphorus dissolves completely into a glass which is red while hot, but colourless and transparent when cold.

$CeF + Ce^2F^3$.

From 100 parts of fluocerite Berzelius obtained:—

Oxide of cerium	82·64
Yttria	1·12

Is found in imbedded crystals and massive, at Broddbo near Fahlun, in albite and sometimes in quartz, with yttrocerite, mica, garnet and yttrotantalite.

439. **YTTROCERITE.**—Yttrocerite; Phillips, Beudant. Pyramidaler Cerer-Baryt; Mohs. Yttrocerit; Hausmann, Haidinger.

Fracture uneven...conchoidal. Translucent...opaque. Lustre vitreous, inclining to waxy, feeble. Dark violet-blue, purple, greyish-red, grey, white. Streak white. Brittle. H = 4·0...4·5. G = 3·447.

Before the blowpipe becomes white, or reddish-white, but does not fuse. With borax and salt of phosphorus melts into a clear glass. In fine powder is easily and completely soluble in boiling hydrochloric acid, forming a yellow solution. Is decomposed by sulphuric acid with evolution of hydrofluoric acid.

CaF, YF, CeF.

According to the analyses of Gahn and Berzelius, 100 parts of yttrocerite from Finbo yielded:—

Oxide of cerium	18·22	16·45

Yttria	9·11	8·10
Lime	47·63	50·00

The quantity of fluorine is equal to the loss together with the oxygen contained in the bases.

Is found in crystalline masses, imbedded in quartz at Finbo and Broddbo near Fahlun, with other fluorides and topaz, and in Massachusetts.

440. **FLUOR.**—Fluor; Phillips. Chaux fluatée; Hauy. Oktaedrisches Fluss-Haloid; Mohs. Fluss; Hausmann, Haidinger.

Cubic.

a 100, *d* 011, *o* 111, *e* 120, *f* 130, *k* 250, *p* 122, *q* 133, *n* 211, *m* 311, *t* 421, *w* 731, *x* 11 5 3.

aa′	90°	0′	*kk′*	46°	24′	*ta*	29°	12′
dd′	60	0	*pa*	70	32	*to*	28	8
da′	45	0	*po*	15	48	*tt′*	35	57
oo′	70	32	*pp′*	27	16	*tt″*	17	45
oa	54	44	*qa*	76	44	*wa*	24	18
ea′	26	34	*qo*	22	0	*wo*	34	14
ed	18	26	*qq′*	37	52	*ww′*	43	13
ee′	36	52	*na*	35	16	*ww″*	12	13
fa′	18	26	*no*	19	28	*xa*	27	56
fd	26	34	*nn′*	33	33	*xo*	28	13
ff′	53	8	*ma*	25	14	*xx′*	39	51
ka′	21	48	*mo*	29	30	*xx″*	13	3
kd	23	12	*mm′*	50	29			

FIG. 615.

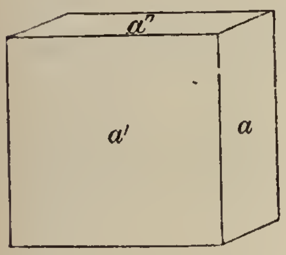


FIG. 616.

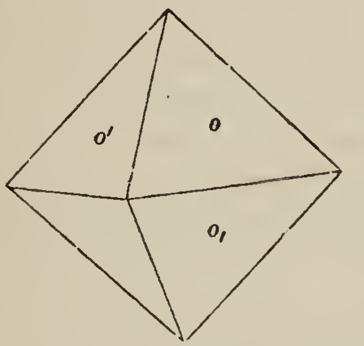


FIG. 617.

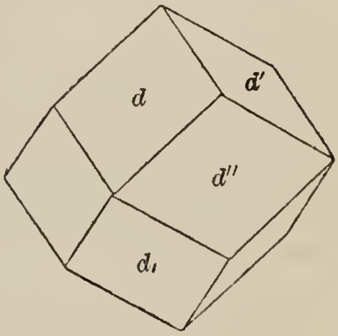


FIG. 618.

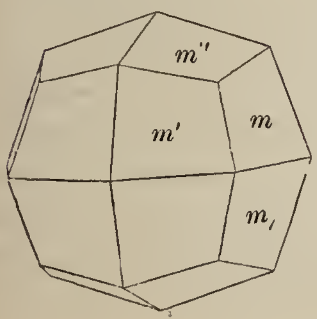


FIG. 619.

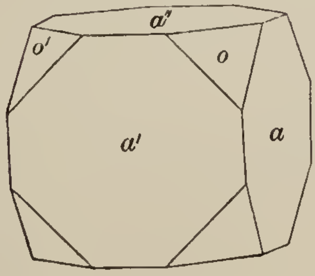


FIG. 620.

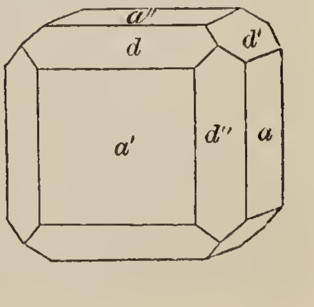


FIG. 621.

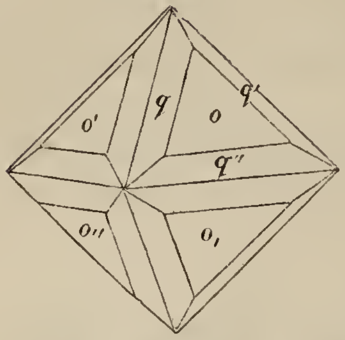


FIG. 622.

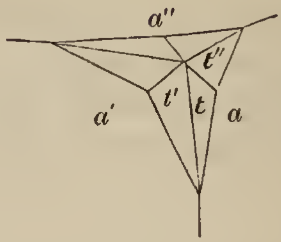
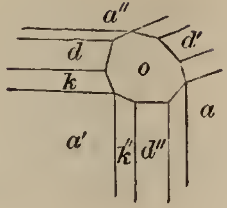


FIG. 623.



Forms and combinations. *a, o, d, f, m, t, ao, ad, af, am, at, ap, oe, oq, op, of, aof, aot, aod, adm, adf, afm, aft, amt, ode, aodt, aodk, aodm, aomf, adef, admt.x.* The faces *a* usually smooth, sometimes striated parallel to their intersections with *e* or *t*; *o* frequently rough; *e, f, k* striated parallel to their intersections with *a*. Twins. Twin-face *o*. Cleavage. *o*, very perfect; *d*, sometimes tolerably distinct; *a*, traces. Fracture conchoidal, more or less perfect. Transparent...translucent. Lustre vitreous. $\mu = 1{\cdot}436$. Colourless, white, grey, yellow, red, blue, green, black. Sometimes different colours appear disposed in layers parallel to the faces of some of the simple forms, and a crystal of one colour occurs imbedded in the interior of a crystal of a different colour. The colours of fluor are sometimes different according as they are seen by reflected or by transmitted light. Some varieties are green by transmitted light, and blue by reflected light. Streak white. Brittle. H = 4·0. G = 3·017...3·188. Phosphoresces when heated or broken, but loses this property when the temperature surpasses a certain limit.

Before the blowpipe, in thin splinters, intumesces and melts into an opaque enamel, which in a strong heat becomes infusible and alkaline, and imparts a red colour to the flame. Readily soluble in borax and salt of phosphorus. With gypsum, baryte or celestine melts into a clear bead, which becomes opaque on cooling. Soluble in hydrochloric and nitric acids. Is completely decomposed by sulphuric acid with evolution of hydrofluoric acid.

CaFl, fluorine 48·53, calcium 51·47.

Berzelius obtained 72·14 and 71·77 parts of lime from 100 parts of fluor from Alston Moor and from Norberg respectively. In fluor from Derbyshire he found 0·5 per cent. of phosphate of lime. According to Kersten, many blue varieties of fluor from Freiberg and Marienberg contain small quantities of chlorine.

In attached crystals, granular or fibrous masses, compact, disseminated, earthy, as the substance of petrified cyathocrinites. The crystals sometimes contain grains of quartz, metallic sulphides, clay, and sometimes drops of water.

Is found in veins in Saxony at Freiberg, Marienberg, Gersdorf, Bräunsdorf, Altenberg, Annaberg, Ehrenfriedersdorf, Johann-Georgenstadt; in Bohemia at Schlackenwald, Zinnwald and Joachimsthal; in Baden in Münsterthal; in England at St. Agnes in Cornwall, Beeralstone in Devonshire, in the lead mines of Derbyshire, Cumberland and Northumberland; in the Harz, Moldawa in the Banat; in veins of silver ore at Kongsberg in Norway. On St. Gotthardt and near Mont Blanc in rose-red octahedrons; in tertiary limestone near Paris; in porphyry near Halle; in porphyritic greenstone near Gourock in Renfrewshire. It is also found at Nertschinsk and many other places in Siberia, in the United States, Mexico, in the masses ejected by Vesuvius. Compact fluor is found at Stolberg, Yxiö in Sweden, Kongsberg, Cornwall; earthy fluor at Marienberg in Saxony, Welsendorf in the Palatinate, Ratofka in Russia, in Durham, and at Beeralstone.

441. SALT.—Muriate of soda; Phillips. Soude muriatée; Hauy. Hexaedrisches Stein-Salz; Mohs. Steinsalz; Hausmann. Salz; Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *e* 210.

aa′	90°	0′
oo′	70	32
oa	54	44
dd′	60	0
da′	45	0
da	90	0
ea′	26	34
ed	18	26

FIG. 624.

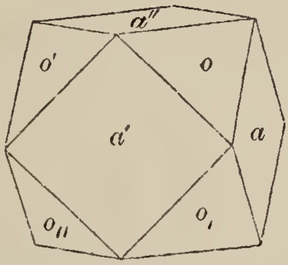
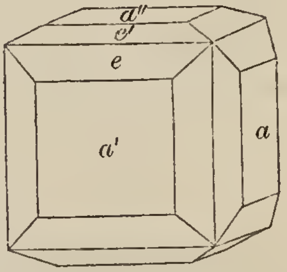


FIG. 625.



Forms and combinations. *a*, *o*, *ao*, *ae*, *aoe*, *ade*. The faces *e* sometimes rough. Cleavage. *a*, very perfect. Fracture conchoidal. Transparent...translucent. Lustre vitreous, inclining to resinous. For red rays $\mu = 1{\cdot}4929$; for green rays $\mu = 1{\cdot}4985$. When transparent transmits heat from sources of different temperatures with equal facility. Colourless, white, grey, yellow, red, green, blue. Streak white. Rather brittle. H = 2·0. G = 2·22. Taste saline.

In the matrass decrepitates and yields a little water. Before the blowpipe on platinum wire melts into a translucent bead with a crystalline surface. Imparts a yellow colour to the flame. On charcoal part is volatile, and part sinks into the charcoal. When added to a bead of salt of phosphorus and oxide of copper, colours the flame blue. Soluble in 3·7 parts of water either hot or cold.

NaCl, chlorine 60·68, sodium 39·32.

Analysis of salt from Cheshire by Henry:—

Chloride of sodium	98·32
Sulphate of lime	0·65
Chloride of magnesium . . .	0·02
Chloride of calcium	0·01
Insoluble matter	1·00

The salt of Berchtesgaden and Hallein contains a small quantity of chloride of potassium. The salt springs of Hall and other places contain some chloride of ammonium.

It occurs in crystals, crystalline, fibrous, granular and compact masses, and pseudomorphous after bitter spar, in beds, occasionally of considerable thickness, especially in the muschelkalk, and between that and the coal formation, with sandstone, clay, gypsum, karstenite and calcite; in the lias, jura limestone, chalk and the tertiary formations, and in some lavas. It occurs also in great abundance on the surface of the earth, at the bottom and on the shores of lakes, and dissolved in their waters, in sea water and in mineral springs.

442. SYLVINE.—Sylvine; Beudant. Sylvin; Hausmann, Haidinger.

Cubic.

a 100, *o* 111.

aa′	90° 0′	
oa	54 44	(figs. 615, 619.)

Form and combination. *a*, *ao*. Cleavage. *a*, perfect. Transparent...translucent Lustre vitreous, inclining to waxy. Colourless, white. G = 1·9...2·0. Taste salt, rather bitter.

Melts before the blowpipe at a red heat and is volatilized. Rather less soluble in water than salt, and more soluble in hot than in cold water.

KCl, chlorine 47·55, potassium 52·45.

Is found in crystals and as an efflorescence on Vesuvius, and occasionally in crystals and massive in blown-out iron furnaces.

443. SAL-AMMONIAC.—Sal ammoniac; Phillips. Ammoniaque muriatée; Hauy. Oktaedrisches Ammoniak-Salz; Mohs. Salmiak; Hausmann, Haidinger.

Cubic.

a 100, *o* 111, *d* 011, *n* 211.

aa'	90°	0'	*dd'*	60°	0'	*no*	19°	28'
oo'	70	32	*da'*	45	0	*nn'*	33	33
oa	54	44	*na*	35	16			

FIG. 626.

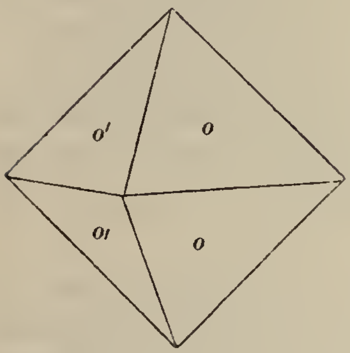


FIG. 627.

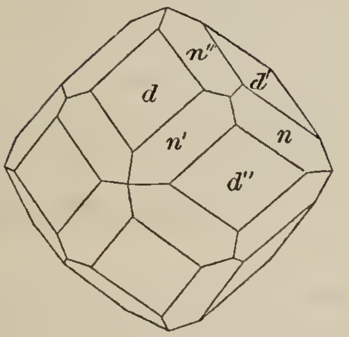
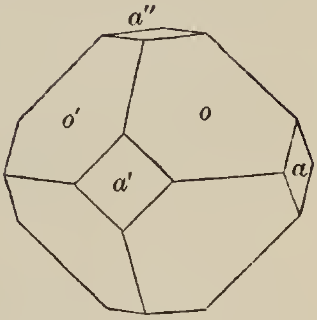


FIG. 628.



Forms and combinations. *a, o, n, ao, dn.* Cleavage. *o*, imperfect. Transparent...translucent. Lustre vitreous. Colourless, white, grey, yellow, brown, black. Streak white. Very sectile. H = 1·5...2·0. G = 1·528.

Is volatilized at a heat a little below redness without melting. Soluble in 2·7 parts of cold water and in one of boiling water. Mixed with moistened quick lime or caustic potash emits the smell of ammonia.

NH^4Cl, chlorine 66·30, ammonium 33·70.

Analyses of sal-ammoniac from Vesuvius, and from Tartary by Klaproth:—

Chloride of ammonium . . .	99·5	97·5
Chloride of sodium	0·5	—
Sulphate of ammonia	—	2·5

In sal-ammoniac from Lanzerote Brandes found traces of magnesia, arsenious acid, and of seleniates and hydriodates.

It has been found in crystals, fibrous and earthy masses, on Vesuvius, the Solfatara of Pozzuolo, on Ætna, Lipari, Volcano, Lanzerote, Bourbon, Iceland, Bucharian Tartary, the Himalaya mountains. It has also been found in burning coal mines at St. Etienne near Lyons, Glan in the Upper Palatinate, near Duttweiler in Saarbrück, Ober-Erlenbach near Frankfort-on-the-Maine, in England near Newcastle, in Scotland.

444. KERATE.—Muriate of silver; Phillips. Argent muriaté; Hauy. Hexaedrisches Perl-Kerat; Mohs. Hornsilber; Hausmann. Kerat; Haidinger.

Cubic.

a 100, *o* 111, *d* 011.

aa′	90°	0′	*dd′*	60°	0′	
oo′	70	32	*da′*	45	0	(figs. 619, 620.)
oa	54	44				

Forms and combinations. *a*, *o*, *d*, *ao*, *ad*. The faces *a* sometimes faintly striated parallel to their intersections with *d*. No cleavage observable. Fracture conchoidal...uneven, earthy. Transparent...translucent on the edges. Lustre waxy, inclining to adamantine. Pearl-grey, passing into various shades of blue and green, yellowish-white. Grows brown when exposed to light. Streak shining. Malleable and sectile. H = 1·0...1·5. G = 5·55...5·60.

Before the blowpipe melts very easily with ebullition, and is gradually reduced into a globule of silver in the inner flame. Is reduced when rubbed with water on iron or zinc. Soluble in ammonia, and crystallizes from the solution in octahedrons.

$AgCl$, chlorine 24·74, silver 75·26.

Analyses of kerate by Klaproth, corrected by Rammelsberg, *a* from Saxony, *b* from Guantahajo in Peru, *c* from Schlangenberg in Siberia:—

	a	*b*	*c*
Silver	67·75	76	68
Chlorine	27·50	24	loss 32
Red ox. iron	6·00	—	—
Alumina	1·75	—	—
Sulphuric acid	0·25	—	—

In crystals, reniform, investing other substances and massive, in veins in the older rocks with some of the other ores of silver.

Is found in considerable quantities at Catorce and Zacatecas in Mexico, Potosi in Peru, los Lodrillos near Copiapo in Chile; also at Schlangenberg near Kolywan in Siberia; in smaller quantities at Allemont in Dauphiné, St. Marie Aux mines in Alsace, Huelgoet in Bretagne, Spain, at Kongsberg in Norway, Huel Mexico and Huel St. Vincent near Calstock in Cornwall. It was formerly abundant in the Saxon mining districts and in the Harz, but is now very scarce. When metallic silver is immersed for a considerable time in salt water, the surface is converted into chloride of silver.

445. EMBOLITE.—Embolit; Breithaupt.

Cubic.

a 100, *o* 111.

aa′	90° 0′	
oa	54 44	(fig. 619.)

Combination. *oa.* The faces *a* rough. Cleavage. *a*, traces. Fracture hackly. Lustre adamantine. Sulphur-yellow...siskin-green on a freshly fractured surface; olive-green...asparagus-green on the exterior. Perfectly malleable. H = 2·0. G = 5·789...5·806.

$2AgBr + 3AgCl$.

Analysis by Plattner:—

Bromine	20·09
Chlorine	13·05
Silver	66·86

Is found in crystals and cleavable masses, and disseminated, in limestone, in the Colorado mine at Copiapo in Chile.

446. BROMITE.—Bromure d'Argent; Dufrénoy. Bromsilber; Hausmann. Bromit; Haidinger.

Cubic.

a 100, *o* 111.

aa′	90° 0′	
oo′	70 32	(figs. 615, 616.)

Forms. *a*, *o*. Bright. Olive-green, passing into yellow; acquires a grey tarnish. Streak siskin-green. H = 1·0...2·0. G = 5·8...6·0.

Melts very easily before the blowpipe. Is but feebly acted upon by acids. Soluble in warm concentrated ammonia.

$AgBr$, bromine 42·56, silver 57·44.

Analysis of bromite from Mexico by Berthier:—

Bromine	42·5
Silver	57·5

Is found rather abundantly, in very small crystals and crystalline grains, with kerate and cerussite, in the mine of San Onofre in the district of Plateros in Mexico, with kerate in the silver mines of Copiapo in Chile, and sparingly among the ores of Huelgoet in Bretagne.

447. IODITE.—Iodic silver; Phillips. Iodure d'Argent; Beudant. Iodinsilber; Mohs. Iodsilber; Hausmann. Iodit; Haidinger.

Transparent...translucent. Lustre resinous, approaching to adamantine. Yellowish-grey...greenish-yellow. Streak shining. H = 1·0. G = 5·504.

Before the blowpipe on charcoal becomes red, melts very easily and imparts a purple colour to the flame; in the inner flame yields a globule of silver. Soluble in concentrated nitric and hydrochloric acids with evolution of vapour of iodine.

AgI, iodine 54·03, silver 45·97.

Analysis of earthy iodite from Chile by Domeyko:—

Iodine	36·88
Silver	64·25

In iodite from Zacatecas Vauquelin found only 18·5 per cent. of iodine.

Is found in crystalline masses, and earthy, in serpentine, at Albarradon near Mazapil in Zacatecas in Mexico, in a vein in the porphyry formation of the mountain of los Algodones to the south of Arqueros in Chile, Hiendelencina in Spain.

The only specimens that we have seen of this mineral were received by Mr. Brooke some years since from Del Rio of Mexico, and stated by him to be from Albarradon.

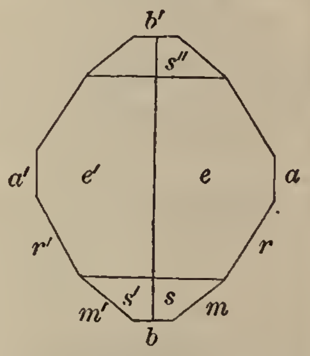
448. COTUNNITE.—Cotunnite; Dufrénoy. Cotunnit; Hausmann, Haidinger.

Prismatic. 011,010=59° 14′; 101,001=26° 38′; 110,100=49° 53′.

a 100, *b* 101, *c* 001, *e* 010, *m* 110, *r* 210, *s* 111.

ab	90°	0′	*ra*	30°	41′
ac	90	0	*rr′*	118	38
bc	90	0	*ss′*	46	38
ee′	53	16	*ss″*	56	2
mm′	80	14	*s′s″*	75	48

FIG. 629.



Transparent. Lustre adamantine, inclining to pearly and silky. For rays refracted in a plane perpendicular to the faces *a*, *b*, and polarized in that plane, $\mu = 1·741$. Colourless, white. Streak white. G = 5·238.

Sublimes in the matrass. Before the blowpipe melts easily, imparting a blue colour to the flame, and depositing a white sublimate on the charcoal. With soda yields globules of lead. Soluble in 135 parts of cold water.

PbCl, chlorine 25·51, lead 74·49.

Was found in acicular and capillary crystals, crystalline plates and small rounded masses, with chloride of sodium, remolinite and sulphate of oxide of copper in the crater of Vesuvius after the eruption of 1822.

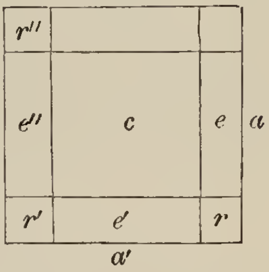
449. CALOMEL.—Muriate of mercury; Phillips. Mercure muriaté; Hauy. Pyramidales Perl-Kerat; Mohs. Hornquecksilber; Hausmann. Kalomel; Haidinger.

Pyramidal. 101,001 = 60° 9′.

a 100, *c* 001, *e* 101, *z* 103, *m* 110, *r* 111, *s* 113. *z* truncates the edge *ec*; *m* truncates the edge *aa′*; *s* is common to the zones *rc*, *za′*.

ac	90°	0′	*zz″*	60°	18′
aa′	90	0	*rc*	67	55
ma	45	0	*rr′*	81	52
ec	60	9	*rr″*	135	50
ee′	75	40	*sz*	26	40
ee″	120	18	*sc*	39	24
zc	30	9	*ss′*	53	20
zz′	41	37	*ss″*	78	48

FIG. 630.



Combinations. *ra*, *rma*, *rea*, *crea*, *rszma*. Cleavage. *a*. Fracture conchoidal...uneven. Translucent...translucent on the edges. Lustre adamantine. R = 1·970. Greyish-white, greenish-grey, yellowish-grey, brown. Streak white. Sectile. H = 1·5. G = 6·4...6·5.

Sublimes in the matrass without melting. With soda yields globules of mercury. Before the blowpipe is wholly volatilized. On copper with water is reduced. Soluble in nitro-muriatic acid, but not in nitric acid. Is partially soluble in warm hydrochloric acid, leaving a grey residue. In caustic potash or soda becomes black.

Hg^2Cl, chlorine 15·05, mercury 84·95.

Is found in attached crystals, disseminated, and investing other minerals, with mercury and cinnabar, at Moschellandsberg in the Palatinate, Giftberg near Horzowitz in Bohemia, Idria in Carniola, and Almaden in Spain.

450. COCCINITE.—Mercure iodure; Dufrénoy. Iodquecksilber; Hausmann. Coccinit; Haidinger.

Lustre adamantine. Red.

Melts and sublimes easily.

Is found at Casas Viejas in Mexico.

This mineral is probably identical with the red crystals of iodide of mercury HgI, iodine 55·9, mercury 44·1, obtained by cooling a warm saturated solution of iodide of mercury in an aqueous solution of iodide of mercury and potassium. These crystals are pyramidal; 101,001 = 66° 37′.

a 100, *c* 001, *x* 111.

ac	90°	0′
xa	48	12
xc	70	30
xx′	83	36

FIG. 631.

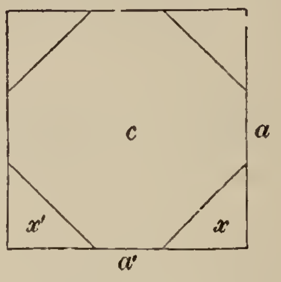
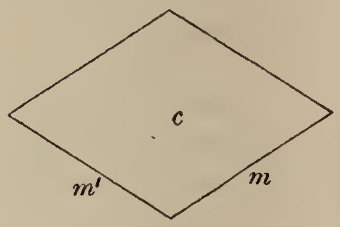


FIG. 632.



Heated to a certain point, they become yellow; at a higher temperature they melt and sublime, forming yellow crystals belonging to the prismatic system (*mc* = 90°, *mm′* = 66°, fig. 632), which on cooling again become red.

HYDROUS CHLORIDES.

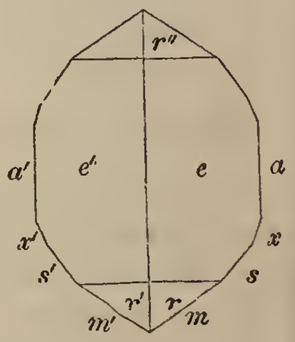
451. REMOLINITE.—Muriate of copper; Phillips. Cuivre muriaté; Hauy. Prismatoidischer Habronem-Malachit; Mohs. Smaragdochalcit; Hausmann. Atacamit; Haidinger.

Prismatic. 011,010=41° 29′; 101,001=37° 10′; 110,100=56° 10′.

a 100, *b* 010, *u* 011, *e* 101, *m* 110, *s* 210, *x* 410, *r* 111. *u* truncates the edge *rr′*.

ab	90°	0′	*xa*	20°	28′
uu′	97	2	*xx′*	139	4
ea	52	50	*ra*	63	20
ee′	74	20	*rm*	36	18
ma	56	10	*rr′*	53	20
mm′	67	40	*rr″*	84	4
sa	36	43	*r′r″*	107	24
ss′	106	34			

FIG. 633.



Combinations. *em*, *eam*, *ubm*, *rbauem*, *raemsx*, *rbaeums*. The faces *m*, *a* striated parallel to their intersections with each other. Cleavage. *a*, perfect; *u*, less perfect. Fracture conchoidal. Semi-transparent...translucent on the edges. Lustre vitreous, inclining to resinous. Green of various shades. Streak apple-green. Rather brittle. H = 3·0...3·5. G = 3·69...3·71.

In the matrass yields water and hydrochloric acid. Before the blowpipe imparts a green colour to the flame, and melts into a globule of copper. Readily soluble in acids. Completely soluble in ammonia.

$CuCl + 3\dot{Cu}\dot{H}$, chlorine 16·63, copper 14·86, oxide of copper 55·84, water 12·67.

Analyses of remolinite *a* from Chile by Klaproth, *b* from Chile, *c* from Peru, both by Proust, *d* from Chile by J. Davy, *e* from Cobija by Berthier, *f* by Ulex:—

	a	*b*	*c*	*d*	*e*	*f*
Hydroch. acid	16·3	10·5	11·5	16·2	—	—
Chlorine	—	—	—	—	14·92	16·12
Copper	—	—	—	—	13·32	14·56
Ox. copper	72·0	76·5	70·5	73·0	50·00	56·23
Water	11·7	12·5	18·0	10·8	21·75	11·99
Silica	—	—	—	—	—	1·10

In attached crystals, reniform, stalactitic, fibrous or granular masses, disseminated. Occurs as a volcanic product. Is sometimes formed by the action of sea water on copper.

Is found in veins with cuprite, malachite, brown iron ore, quartz, at Los Remolinos, Guasko, Soledad in Chile, in veins of silver ores in the district of Tarapaca in Peru, Schwarzenberg in Saxony, on the lavas of Vesuvius and Ætna.

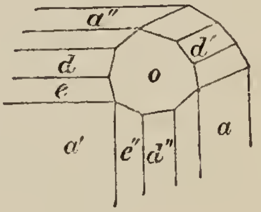
452. PERCYLITE.—Percylite; Brooke. Phil. Mag. Feb. 1850.

Cubic.

a 100, *d* 011, *e* 210, *o* 111.

aa'	90°	0'	*ea'*	26°	34'
dd'	60	0	*oa*	54	44
da'	45	0	*od*	35	36

FIG. 634.



Combination. *adoe.* Lustre vitreous. Sky-blue. Streak the same. H = 2·5.

When slightly heated the blue colour changes to emerald-green, and re-appears on cooling. In the matrass decrepitates and yields water, which does not redden litmus paper. It readily melts into a brown liquid which diffuses itself in drops over the contiguous surface of the tube, and on cooling becomes a pale brown fissured mass. Heated in the open tube, a white, not sensibly odorous, vapour is evolved. Heated in the outer flame of the blowpipe, the flame is green within and deep blue at the edges. On charcoal in the inner flame, metallic globules are obtained, some having the appearance of lead, others that of copper, or a mixture of copper and lead. On charcoal in the inner flame with soda yields metallic globules, which dissolve without residue in dilute nitric acid. With borax in the outer flame melts into a transparent blueish-green bead, which in the inner flame becomes turbid and brownish-red. By boiling in nitric acid becomes white and then dissolves..

The analysis by Dr. Percy of a very small unknown quantity, separated from the matrix by boiling in nitric acid, gave:—chlorine 0·84, lead 2·66, copper 0·77: whence Dr. Percy concludes the composition of the mineral to be represented by the formula $\mathrm{PbCl} + \dot{\mathrm{Pb}} + \mathrm{CuCl} + \dot{\mathrm{Cu}} + \mathrm{x}\dot{\mathrm{H}}$.

In minute crystals, accompanied by gold, on a matrix of quartz and earthy hematite, said to have come from La Sonora in Mexico.

CHLORIDE WITH SULPHATE.

453. CONNELLITE.—Sulphato-chloride of copper; Connell. Connellite; Dana.

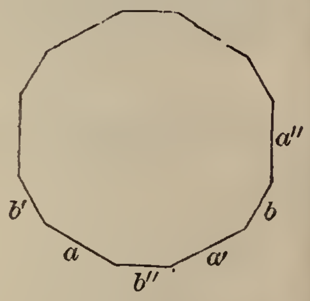
Rhombohedral.

a $01\bar{1}$, *b* $2\bar{1}\bar{1}$.

aa'	60°	0'
ab	30	0

Lustre vitreous. Translucent. Blue.

FIG. 635.



In the matrass yields a little water. Decrepitates when heated, imparts a fine greenish-blue to the flame, and melts before the blowpipe into a dark reddish globule. Completely soluble in nitric and in hydrochloric acid. Insoluble in water.

Consists, according to Connell, of chloride of copper, sulphate of oxide of copper, and a little water.

Was found in small fibrous crystals, with an arseniate of oxide of copper, in Cornwall.

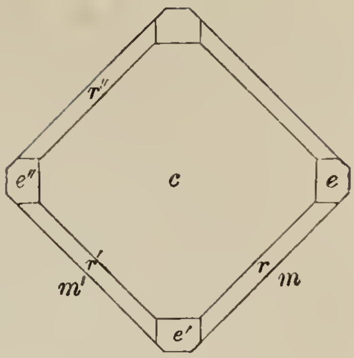
CHLORIDES WITH OXIDES AND CARBONATES.

454. MATLOCKITE.—Matlockite; R. P. Greg. Philosophical Magazine. August, 1851.

Pyramidal. 101,001 = 60° 26'.

c 001, *e* 101, *m* 110, *r* 111.

FIG. 636.



ec	60°	26′	*mm′*	90°	0′
ee′	75	54	*rr′*	82	2
ee″	120	52	*rr″*	136	19
mc	90	0	*er*	41	1

Cleavage. *c*, not very easily obtained. Fracture uneven and slightly conchoidal. Transparent...translucent. Lustre adamantine, occasionally pearly. Yellowish, with sometimes a greenish tinge. H = 2·5...3·0. G = 7·21.

Decrepitates when heated. Fusible before the blowpipe into a greyish-yellow globule.

$\text{PbCl} + \dot{\text{Pb}}$, chloride of lead 55·46, oxide of lead 44·53.

Analysis by Dr. R. A. Smith :—

Chloride of lead	55·18
Oxide of lead	44·30
Water	0·07

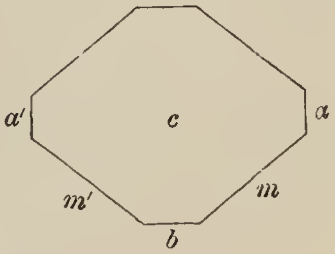
Was found in tabular crystals, generally thin and superimposed on each other, and occasionally slightly curved, in old heaps from the Cromford level near Matlock.

455. MENDIPITE.—Kerasine; Beudant. Peritomer Blei-Baryt; Mohs. Mendipit; Hausmann, Haidinger.

Prismatic.

a 100, *b* 010, *c* 001, *m* 110.

FIG. 637.



ac	90°	0′	*ma*	51°	18′
bc	90	0	*mb*	38	42
ab	90	0	*mm′*	77	24

Cleavage. *m*, very perfect; *a*, *b*, less perfect. Fracture conchoidal...uneven. Translucent. Lustre, adamantine inclining to pearly on the cleavages. Yellowish-white, straw-yellow, pale red, pale blue. Streak white. H = 2·5...3·0. G = 7·0...7·1.

Decrepitates when heated. Melts readily before the blowpipe into a yellow globule. On charcoal is easily reduced, emitting acid fumes. Fused with salt of phosphorus and oxide of copper, imparts a blue colour to the flame. Is readily soluble in nitric acid.

$\text{PbCl} + 2\dot{\text{Pb}}$, chloride of lead 38·39, oxide of lead 61·61.

Analyses of mendipite *a* from the Kunibert mine near Brilon by Schnabel, *b* from Brilon, G = 7·0, by Rhodius, *c* from Churchill by Berzelius :—

	a	*b*	*c*
Oxide of lead	61·26	60·10	60·18
Chloride of lead	38·74	39·07	39·82

Is found in columnar crystalline masses, with other ores of lead, calcite and earthy black manganese, at Churchill in the Mendip Hills in Somersetshire, and at Brilon in Westphalia.

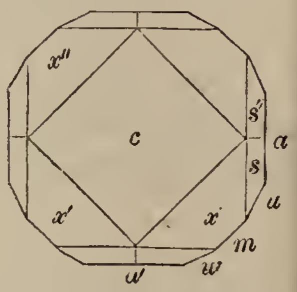
456. PHOSGENITE.—Murio-carbonate of lead; Phillips. Plomb carbonaté muriatifère; Hauy. Orthotomer Blei-Baryt; Mohs. Hornblei; Hausmann. Phosgenit; Haidinger.

Pyramidal. 101,001 = 47° 19′·6.

a 100, *c* 001, *e* 101, *m* 110, *u* 210, *x* 111, *s* 211. *e′* truncates the edge *xx′*.

ac	90°	0′	*xm*	33°	6′
ad′	90	0	*xx″*	113	48
ma	45	0	*xx′*	72	39
ua	26	34	*sa*	34	13
um	18	26	*sc*	67	36
ee′	94	39	*sm*	28	34
xc	56	54	*ss″*	48	50

FIG. 638.



Combinations. *cmax*, *cmau*, *cmaex*, *cmaux*, *cmauxs*. Cleavage. *a* ; *m* ; *c*. Fracture conchoidal. Transparent…translucent. Lustre adamantine, inclining to waxy. Colourless, white, passing into grey, yellow, green, brown. Streak white. Brittle. H = 3·0. G = 6·0…6·2.

Before the blowpipe in the outer flame melts readily into an opaque yellow bead, which becomes white and crystalline on cooling. On charcoal in the inner flame yields acid vapours and is reduced to metallic lead. Is soluble with slight effervescence in nitric acid.

$\mathrm{Pb\,Cl} + \dot{\mathrm{Pb}}\ddot{\mathrm{C}}$, chloride of lead 51·00, carbonate of oxide of lead 49·00.

Analysis by Dr. R. A. Smith :—

Chloride of lead	51·78
Carbonate of oxide of lead . .	48·22

Phosgenite has been found, in crystals and globular masses, in Cromford level near Matlock in Derbyshire, Cornwall, and is said to have been found on Vesuvius, Badenweiler in Baden, and Southampton in Massachusetts.

HYDROUS OXALATES.

457. **HUMBOLDTINE.**—Oxalate of iron; Phillips. Fer oxalaté; Hauy. Humboldtin; Mohs, Haidinger. Oxalit; Hausmann.

Fracture uneven...earthy. Opaque. Lustre waxy, glimmering or dull. Yellow. Streak yellow. Slightly sectile. H = 2·0. G = 2·15...2·25.

Before the blowpipe blackens and then turns red. Imparts the colour of iron to borax and salt of phosphorus. Insoluble in water and alcohol. Readily soluble in acids. With alkalies yields a precipitate of protoxide of iron.

$2\dot{\mathrm{Fe}}\,\dddot{\mathrm{C}} + 3\dot{\mathrm{H}}$, oxalic acid 42·11, protoxide of iron 42·11, water 15·78.

Analyses of humboldtine by Rammelsberg:—

Oxalic acid	42·40	not determined	
Protoxide of iron . .	41·13	40·24	40·8
Water	16·47	not determined	

Is found in capillary crystals, and botryoidal, granular or fibrous masses, with gypsum in a bed of brown coal at Kolosoruk near Bilin in Bohemia. It is said to occur also in brown coal at Gross Almerode in Hessia.

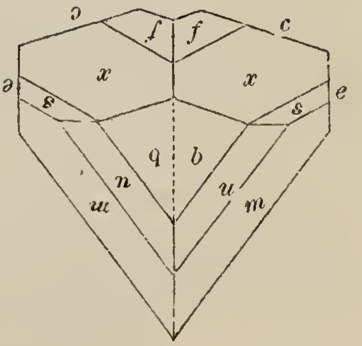
458. **WHEWELLITE.**—Oxalate of lime; Brooke. Phil. Mag. June, 1840. Oxalsaurer Kalk; Haidinger.

Oblique. 101,100 = 36° 47′; 111,010 = 50° 39′; 101,001 = 70° 32′.

b 010, *c* 001, *x* 011, *e* 101, *m* 110, *u* 120, *f* $\bar{1}12$, *s* 132.

cb	90°	0′	*cf*	38°	54′
eb	90	0	*cm*	103	14
ec	70	32	*fe*	100	48
xc	52	35	*ex*	78	19
xb	37	25	*em*	51	58
xx′	74	50	*sc*	69	58
mb	50	18	*se*	64	28
mm′	100	36	*sm*	43	13
uu′	62	7	*xm*	68	24
fb	65	39	*fm*	105	15
ff′	121	18	*uc*	98	50
sb	28	41	*ue*	65	36
ss′	57	22			

FIG. 639.



The faces *m* are striated parallel to their intersections with *u*; *f* striated parallel to their intersections with each other. Twins. Twin-face *e*. *co* = 38° 56′, *xx* = 23° 22′, *ss* = 51° 4′, *mu* = 76° 4′, *un* = 48° 48′, *ff* = − 21° 36′. Cleavage. *c*, *m*, *b*. Fracture conchoidal. Transparent…opaque. Lustre vitreous, inclining to adamantine. Colourless. Streak white. Very brittle. H = 2·5…2·75. G = 1·833.

$\dot{\mathrm{Ca}}\dddot{\mathrm{C}} + \dot{\mathrm{H}}$, oxalic acid 49·31, lime 38·36, water 12·33, according to an analysis by Sandall.

In small attached crystals, mostly twins, with calcite. Is supposed to have been found in Hungary.

HYDROUS MELLATE.

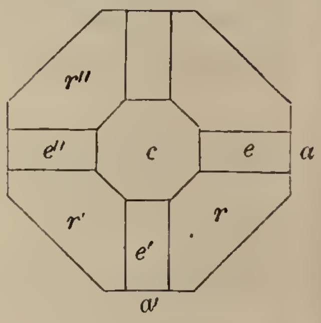
459. MELLITE.—Mellite; Phillips, Hauy. Pyramidales Melichron-Harz; Mohs. Mellit; Hausmann, Haidinger.

Pyramidal. 101,001 = 36° 44′.

a 100, *c* 001, *e* 101, *r* 111.

ac	90°	0′	*ra*	59°	7′
aa′	90	0	*rc*	46	33
ea	53	16	*rr′*	61	46
ec	36	44	*re*	30	53
ee′	50	2	*rr″*	93	6

FIG. 640.



Combinations. *cr*, *ra*, *cra*, *cera*. The faces *c* rough and curved; *e* rough. Cleavage. *r*, very difficult. Fracture conchoidal. Transparent…translucent. Lustre resinous, inclining to vitreous. R = 1·538…1·556. Honey-yellow, inclining to red or brown. Streak white. Sectile. H = 2·0…2·5. G = 1·5…1·6.

In the matrass yields water, and carbonizes without emitting any perceptible smell. Before the blowpipe on charcoal burns white, leaving nothing but alumina. Completely soluble in nitric acid, in hydrochloric acid, and in caustic potash.

$\dddot{\mathrm{Al}}\mathrm{C}^4\mathrm{O}^3 + 18\dot{\mathrm{H}}$, mellitic acid 40·31, alumina 14·35, water 45·34.

Analysis of mellite from Artern by Wöhler:—

Mellitic acid	41·4
Alumina	14·5
Water	44·1

Is found in imbedded crystals, in beds of brown coal at Artern in Thuringia, Lauschitz near Bilin in Bohemia, and sparingly, massive, at Walchow in Moravia.

RESINS.

460. SCHEERERITE.—Scheererite; Beudant. Scheererit; Mohs, Hausmann, Haidinger.

Oblique.

Fracture conchoidal. Transparent...translucent. Lustre resinous...adamantine. White, inclining to grey, yellow, green. Streak white. Brittle. Unctuous to the touch. Soft. G = 1·0...1·2. Tasteless.

When heated emits a faint aromatic smell. At 44° C melts into a colourless oily liquid, and crystallizes on cooling. At 92° C distils unchanged. Burns with a smoky flame, and a faint aromatic odour, leaving no residue. Insoluble in water. Soluble in alcohol, æther, nitric and sulphuric acids.

CH^2, carbon 75, hydrogen 25.

Analysis of scheererite from Uznach by Macaire-Prinsep:—

Carbon	73
Hydrogen	24

Is found in crystals filling crevices in brown coal, at Uznach near St. Gallen, and at Bach in the Westerwald.

461. KÖNLEINITE.—Konlite; Dufrénoy. Könleinit; Hausmann. Könlit; Haidinger.

White. G = 0·88.

Melts at 107·5...114° C. Burns with a smoky flame and an empyreumatic smell, without leaving any ash. Crystallizes from its solution in boiling alcohol in thin plates.

C^2H, carbon 92·31, hydrogen 7·69.

Analyses of könleinite from Uznach by Kraus and from Redwitz by Trommsdorf:—

Carbon	92·49	92·43
Hydrogen . . .	7·42	7·57

Is found in crystalline plates and grains, in brown coal at Uznach near St. Gallen in Switzerland, with sheererite, and at Redwitz in Bavaria, in bituminous wood in a peat bog.

462. FICHTELITE.—Fichtélite; Dufrénoy. Fichtelit; Hausmann, Haidinger.

Transparent. Lustre pearly. Colourless. Unctuous to the touch. Without taste or smell. Melts at 46° C, and on cooling forms a crystalline mass. Sparingly soluble in anhydrous alcohol. Easily soluble in æther.

Analysis of fichtelite from Redwitz by Bromeis :—

Carbon	89·3
Hydrogen	10·7

Is found in flat acicular crystals, between the yearly rings of pine stems, in a bed of turf at Redwitz near the Fichtelgebirge.

463. HARTITE.—Hartite; Dufrénoy. Hartit; Hausmann, Haidinger.

Traces of cleavage. Fracture conchoidal. Translucent. Lustre fatty, feeble. White. H = 1·0. G = 1·046. Not flexible. Sectile. At 74° C melts into a clear fluid. When heated emits a smell like that of amber. Burns with a smoky flame. Readily soluble in æther, much less soluble in alcohol.

Analyses of hartite from Oberhart by Schrötter :—

Carbon	87·47	87·50
Hydrogen	12·05	12·10

Is found in clefts in brown coal and fossil wood at Oberhart near Gloggnitz in Austria.

464. OZOKERITE.—Ozokerite; Dufrénoy. Ozokerit; Hausmann, Haidinger.

Fracture in one direction flat conchoidal, in other directions splintery. Lustre waxy, more or less bright on the conchoidal fracture, glimmering on the splintery fracture. In thin fragments transparent...translucent on the edges. By reflected light dark leek-green inclining to brown, by transmitted light yellowish-brown, honey-yellow and hyacinth-red. Streak yellowish-white. H = 1·0. G = 0·94...0·97. Sectile, tough and flexible; can be cut like wax; when warmed may be kneaded between the fingers. Smell aromatic and bituminous. Acquires resinous electricity by friction.

At 62° C melts into a clear oily liquid, which becomes solid on cooling. Burns with a bright slightly smoky flame. Easily soluble in oil of turpentine, with difficulty in æther and alcohol.

CH, carbon 85·72, hydrogen 14·28.

Analyses of ozokerite from Slanik *a* by Magnus, *b* by Schrötter, *c*, *d*, *e* by Malagutti, *f* from Urpeth by Johnston :—

	a	b	c	d	e	f
Carbon	85·75	86·20	86·21	86·20	85·80	86·80
Hydrogen	15·15	13·79	13·71	14·16	13·98	14·06

Is found at Slanik and Zietrisika in Moldavia, Gresten in Austria, and in the coal mines of Urpeth near Newcastle in England.

465. HATCHETTINE.—Hatchetine; Phillips, Beudant. Hatchetin; Mohs, Hausmann, Haidinger.

Translucent…nearly opaque. Lustre slightly pearly. Yellowish-white, wax-yellow, greenish-yellow. H = 1·0. G = 0·6078 (after fusion G = 0·983).

Melts (from Loch-Fyne at 47° C, from Merthyr-Tydvil at 76·6° C) into a transparent colourless liquid, which becomes opaque and white on cooling. Emits a bituminous smell when heated. Partially soluble in æther, leaving a viscous, inodorous residue.

CH, carbon 85·72, hydrogen 14·28.

Analysis of hatchettine from Glamorganshire by Johnston:—

Carbon	85·91
Hydrogen	14·62

Is found in masses resembling wax or train oil, in several places in the coal formation in England, at Loch-Fyne and Inverary in Scotland.

466. MIDDLETONITE.—Middletonite; Johnston. Phil. Mag. 12. 261, Dufrénoy. Middletonit; Hausmann, Haidinger.

In thin fragments transparent. Lustre resinous. By reflected light reddish-brown, by transmitted light deep red. Streak light brown. G = 1·6. Brittle. Melts at a temperature above 222° C. Burns with much smoke. Very slightly soluble in alcohol, æther and oil of turpentine. Soluble in concentrated sulphuric acid.

Analyses by Johnston:—

Carbon	86·44	85·44	87·74
Hydrogen	8·01	8·03	8·05
Oxygen	5·56	6·53	5·22

Is found in small rounded masses, or thin seams between layers of coal at Middleton near Leeds, and at Newcastle.

467. PSATHYRITE. — Hartin; Hausmann, Haidinger. Psathyrit; Glocker.

White. G = 1·115. Without taste or smell.

Melts at 210° C. Distils at 260° C, yielding a yellow oil having an empyreumatic smell, and which forms a brownish-yellow crystalline mass on cooling. Burns with a bright flame. Soluble in petroleum, and crystallizes from the solution in long needles.

Analysis of psathyrite from Oberhart by Schrötter:—

Carbon	78·26
Hydrogen	10·92
Oxygen	10·82

Is found in masses resembling train oil, with hartite in brown coal, at Oberhart near Gloggnitz in Austria.

468. GUYAQUILLITE.—Guyaquillite; Johnston. Phil. Mag. 13. 329, Dufrénoy. Guyaquillit; Hausmann, Haidinger.

Amorphous. Opaque. Bright yellow. Soft. G = 1·092.

At 69·5° C melts, at 100° C is perfectly liquid; after cooling is viscous, translucent, and has a resinous lustre and fracture. Soluble in alcohol, forming a yellow intensely bitter solution. In concentrated sulphuric acid forms a reddish-brown solution.

Analyses by Johnston:—

Carbon	76·67	77·35
Hydrogen	8·17	8·20
Oxygen	15·16	14·45

Is found at Guyaquil in South America.

A substance found in the Irish bogs, and known by the name of 'bog-butter,' appears to be allied to guyaquillite. It melts at 50° C, is readily soluble in alcohol, and consists, according to Williamson's analyses, of—

Carbon	73·78	73·89
Hydrogen	12·50	12·37
Oxygen	13·72	13·74

469. BERENGELITE.—Bérengelite; Johnston. Phil. Mag. 13. 329, Dufrénoy. Berengelit; Hausmann, Haidinger.

Amorphous. Fracture conchoidal. Lustre resinous. Dark brown, inclining to green. Streak yellow. Taste bitter.

Melts below 100° C, and remains soft and unctuous. Soluble in cold alcohol, forming a bitter solution, and in æther.

Analyses by Johnston:—

Carbon	72·47	72·34
Hydrogen	9·20	9·36
Oxygen	18·33	18·30

Is found in large masses in the province of St. Juan de Berengela in South America.

470. RETINASPHALT.—Retinasphalt; Phillips, Beudant, Mohs. Retinit; Hausmann, Haidinger.

Amorphous. Fracture conchoidal. Semi-transparent… opaque. Yellow, brown, grey. Streak yellowish-brown. Brittle. H = 1·0…2·0. G = 1·05…1·20. Acquires resinous electricity by friction.

Burns with a flame, and emits a bituminous aromatic smell.

Analyses of retinasphalt *a* from Bovey by Hatchett, *b* from Halle by Bucholz, *c* from Cape Sable by Troost, *d* from Bovey by Johnston:—

	a	*b*	*c*	*d*
Resin soluble in alcohol	55	91	55·5	59·32
Substance insoluble in alcohol . .	41	9	42·5	27·45
Earthy matter	3	—	1·5	13·23

It is probable that different substances are united under the name retinasphalt.

Is found in brown coal near Halle, at Laubach in the Vogelsgebirge, Bovey in Devonshire, Cape Sable in Maryland, at Radnitz in Bohemia in stone coal, near Osnabrück in peat.

471. COPALINE.—Fossil copal; Phillips. Copale fossile; Dufrénoy. Copalin; Hausmann. Retinit; Haidinger.

Amorphous. Fracture conchoidal. Semi-transparent…translucent. Lustre waxy. Yellow, yellowish-brown. H = 2·5. G = 1·046. Brittle. When heated emits a resinous, aromatic smell. Melts into a clear fluid. Burns with a bright yellow flame and much smoke, leaving little or no residue. Very slightly soluble in alcohol and æther.

Analyses of copaline *a*, *b* from Highgate by Johnstone, *c* from the East Indies by Duflos:—

	a	*b*	*c*
Carbon	85·41	85·68	85·73
Hydrogen	11·79	11·48	11·50
Oxygen	2·67	2·84	2·77
Ash	0·13	—	—

Is found in blue clay at Highgate near London and in the East Indies.

472. WALCHOWITE. — Walchowit; Hausmann, Haidinger.

Amorphous. Fracture conchoidal. Translucent...translucent on the edges. Lustre fatty. Yellow, brown. Streak yellowish-white. Brittle. H = 1·5...2·0, G = 1·035...1·069. At 140° C becomes translucent and elastic; at 250° C melts into a yellow oil. Burns with a smoky flame and aromatic smell.

Soluble in 67 parts of alcohol, and in 13 parts of æther. Soluble in sulphuric acid, forming a dark brown solution.

Analyses by Schrötter:—

Carbon	80·30	80·19	80·70
Hydrogen	10·68	10·74	10·62
Oxygen	9·02	9·08	8·68
Nitrogen	0·18	0·18	0·18

Is found in brown coal, at Walchow in Moravia.

473. AMBER.—Amber; Phillips. Succin; Hauy. Gelbes Erd-Harz; Mohs. Bernstein; Hausmann. Succinit; Haidinger.

Amorphous. Transparent...translucent. Lustre waxy. μ = 1·5. Yellow of various shades, hyacinth-red, brown, white. Streak yellowish-white. Slightly brittle. H = 2·0...2·5. G = 1·0...1·1. Acquires resinous electricity by friction.

At 287° C melts and is decomposed, yielding water, an empyreumatic oil and succinic acid. Burns with a bright flame and a peculiar smell, leaving a carbonaceous residue.

$C^{10}H^{8}O$, carbon 78·96, hydrogen 10·57, oxygen 10·57.

Analysis by Schrötter:—

Carbon	78·82
Hydrogen	10·23
Oxygen	10·95

In rounded masses and disseminated, frequently containing air bubbles, insects and parts of plants. Is supposed to be derived from the resins of extinct coniferæ.

It occurs principally in the tertiary brown coal formations. Is found in Sicily between Catania and Semito, in Prussia principally between Palmnicken and Gross-Hubenicken, Pomerania, Holstein, Courland, Livonia, Greenland, China, France, Italy, Spain, England, Ireland.

474. NAPHTHA.—Naphtha; Phillips, Beudant. Schwarzes Erd-Harz; Mohs. Erdöl; Hausmann. Bitumen; Haidinger.

Liquid. Transparent...translucent. Colourless...yellow...brown. G = 0·7...0·8. Unctuous to the touch. Smell aromatic and bituminous. Boils at a temperature below 100° C. Burns with a bituminous smell. Soluble in absolute alcohol.

Analyses by Dumas:—

Carbon	84·65	88·02	85·40	87·70	86·40
Hydrogen	13·31	11·98	14·23	13·00	12·70

Oozes either alone or with water out of clefts in rocks, or out of the ground at Häring and Tegernsee in the Alps, Amiano near Parma and many other places in Italy, Salies in the Pyrenees, several places in the United States, Persia, the East Indies, China, Baku on the Caspian.

By exposure to the air naphtha becomes thick and at last solid. Petroleum, elaterite and asphaltum are supposed to be naphtha more or less altered by exposure.

Petroleum, at the usual temperature, is rather thicker than common tar, has a bituminous odour, and is of a blackish or reddish-brown colour, burns with a thick black smoke, is slightly soluble in alcohol, and very soluble in æther and in volatile and fat oils. G = 0·8…1·2.

Analyses of petroleum from Bechelbrunn and from Hatten in Alsace by Boussingault:—

Carbon	88·3	88·7
Hydrogen	11·1	12·6

Is found in Hanover, Brunswick, Pont du Chateau and many other places in Auvergne, Bechelbrunn, Hatten and Lobsann in Alsace, Zante, Barbados, forming a lake in Trinidad, in England at Ormskirk in Lancashire, and at Coal Port near Coalbrookdale, at St. Catharine's Well near Edinburgh, in the isle of Pomona, Rangoon in Ava.

Elaterite is soft, yields easily to pressure, is flexible and elastic like caoutchouc, brown or black. G = 0·8…1·23.

Analyses of elaterite from Derbyshire by Johnston:—

Carbon	85·47	84·39	83·67	85·96	86·18
Hydrogen	13·28	12·58	12·54	12·34	12·42

Is found in the Odin mine at Castleton in Derbyshire, Montrelais not far from Nantes in France, Woodbury in Connecticut.

Asphaltum is solid with a conchoidal fracture, opaque with a shining waxy lustre, black, inclining to brown, and has a brown streak. H = 2·0. G = 1·1…1·2. Acquires resinous electricity by friction. Melts at a little above 100° C. Burns with a smoky flame, leaving a small quantity of ashes.

Analyses of asphaltum from Auvergne by Ebelmen, and from Peru by Boussingault :—

Carbon	76·13	88·63
Hydrogen	9·41	9·69
Oxygen	10·34	1·68
Nitrogen	2·32	
Ash	1·80	—

Is found at Limmer in Hanover and near Münster, at Soult, Lobsann, Bechelbrunn, on the Rhone from Seyssel to the Perte du Rhone, in Val Travers in Neufchatel, the Dead Sea, Avlona in Albania, in a vein in Carharack mine in Cornwall, in veins in Haughmond hill in Shropshire, in East Lothian.

475. IDRIALINE.—Idrialine; Dufrénoy. Braunes Erd-Harz; Mohs. Idrialit; Hausmann, Haidinger.

Fracture uneven. Opaque. Lustre resinous. Greyish-black, brownish-black...reddish-brown. Streak brown, shining. Unctuous. Sectile. H = 1·0...1·5. G = 1·4...1·6.

Melts at between 250° C and 300° C. In the matrass sublimes and is deposited in bright iridescent scales. Inflammable. Soluble in hot oil of turpentine, olive oil, alcohol, æther, acetic acid, kreosote. The solution, on cooling, deposits it in greenish-yellow, pearly, crystalline scales. Imparts a yellow colour to sulphuric acid.

Analyses *a* by Dumas, *b*, *c* by Schrötter, *d* by Bödeker :—

	a	*b*	*c*	*d*
Carbon	94·9	94·50	94·80	91·83
Hydrogen	5·1	5·19	5·49	5·30
Oxygen	—	—	—	2·87

Is found mechanically mixed with a large and variable quantity of cinnabar and other substances, in thin layers in slate, in the quicksilver mines of Idria.

476. IXOLYTE.—Ixolyt; Hausmann, Haidinger.

Amorphous. Fracture conchoidal...earthy. Lustre resinous on the surface of fracture. Hyacinth-red. Streak yellow... brown. Sectile. H = 1·0. G = 1·008. Smell aromatic.

Softens at 76° C and can be drawn into threads at 100° C.

Is found with hartite, filling up cracks in wood converted into brown coal, at Oberhart near Gloggnitz in Austria.

477. PIAUZITE.—Piauzit; Hausmann, Haidinger.

Fracture imperfect conchoidal. Translucent on the thinnest edges. Blackish-brown. Streak yellowish-brown. Sectile. H = 1·5. G = 1·220.

Melts at 315° C. Burns with an aromatic smell, and bright flame. Completely soluble in æther and caustic potash.

Is found in a bed of brown coal near Piauze in Carniola.

COAL.

478. COAL.—Harzige Stein-Kohle, Harzlose Stein-Kohle; Mohs. Anthracit, Schwarzkohle, Braunkohle; Hausmann. Anthrazit, Harzige Steinkohle; Haidinger.

Of this substance there are three varieties: 1. anthracite; 2. black coal; 3. brown coal; all of vegetable origin.

1. Anthracite.—Fracture conchoidal. Lustre vitreous or waxy. Black. Streak black. Brittle. H = 2·0...2·5. G = 1·3...1·75. Conducts electricity perfectly.

Burns with a weak flame. Deflagrates with nitre. Imparts no colour to caustic potash.

Analyses of anthracite *a* from Pennsylvania, *b* from Herzogenrath near Aix la Chapelle, both by Regnault, *c* from Coalbrookdale by Jacquelin, *d* from Pembrokeshire by Schafhäutl:—

	a	*b*	*c*	*d*
Carbon	90·45	91·45	90·58	94·10
Hydrogen . . .	2·43	4·18	3·60	2·39
Oxygen . . . . }	2·45	2·12	3·81	1·34
Nitrogen . . . }			0·29	0·87
Ash	4·67	2·25	1·72	1·30

Is found in several parts of the Alps, the Pyrenees, in many parts of France, Pennsylvania, Massachusetts, Bohemia, Silesia, Saxony, the Meissner in Hessia, near Walsall in Staffordshire, Brecknockshire, Carmarthenshire, Pembrokeshire, Cumnock and Kilmarnock in Scotland, Kilkenny in Ireland.

2. Black coal. Fracture conchoidal...uneven. Lustre waxy. Black. Streak black. Slightly sectile...brittle. H = 2·0...2·5.

Burns with a smoky flame and bituminous smell. Imparts sometimes a yellow or brown colour to caustic potash.

Analyses of black coal *a* from Lancashire, *b* from Blanzy, *c* from Epinac, all by Regnault, *d* from Newcastle by Richardson, *e* from Monte Massi near Pisa by Bunsen:—

	a	*b*	*c*	*d*	*e*
Carbon	83·75	76·48	81·12	87·95	73·63
Hydrogen	5·66	5·23	5·10	5·24	5·28
Oxygen and nitrogen .	8·04	16·01	11·25	5·41	17·89
Earthy matter . . .	2·55	2·28	2·53	1·40	3·20

This is the common coal of the British collieries. It is found also in Germany, Bohemia, Moravia, Belgium, France, Asturias, North America, China, Japan, Australia.

3. Brown coal.—Fracture conchoidal...earthy. Lustre waxy. Brown...black. Streak brown. H = 1·0...2·5. G = 0·5...1·5.

Burns with a smoky flame and unpleasant smell. Imparts a dark brown colour to caustic potash.

Analyses of brown coal *a* from Elbogen, *b* from Dax, *c* from the Meissner, *d* from Uznach, all by Regnault:—

	a	*b*	*c*	*d*
Carbon	73·79	70·49	71·71	56·04
Hydrogen	7·46	5·59	4·85	5·70
Oxygen and nitrogen	13·79	18·93	21·67	36·07
Ash	4·96	4·99	1·77	2·19

Brown coal exhibits the structure of wood much more distinctly than the other varieties of coal.

It occurs principally in the tertiary formations and in alluvium. It is found in various parts of Germany, Switzerland, Aix in Provence, Hungary, Italy, Greece, Iceland, Greenland, near Bovey Tracey in Devonshire, at the mouth of the Ouse in Sussex, in Scotland in Fife and Mid Lothian, and in the isles of Sky and Canna, in the Faröe isles, particularly in Suderöe, in Antrim in Ireland imbedded in trap.

APPENDIX.

CONTAINING

MINERALS THE COMPOSITION OF WHICH IS UNKNOWN OR DOUBTFUL, AND WHICH ARE OTHERWISE IMPERFECTLY DESCRIBED.

GOLD AMALGAM.—In small white globules, in the platinum stream-works of Columbia. Analysis by Schneider:—mercury 57·40, gold 38·39, silver 5·00.

KANEITE.—In granular masses. Lustre metallic. Greyish-white. G = 5·5. $Mn^2 As$. Analysis by Kane:—manganese 45·5, iron a trace, arsenic 51·8. Saxony.

APHTHONITE.—Steel-grey, compact. G = 4·87. Melts easily before the blowpipe. Analysis by Svanberg:—sulphur 30·05, antimony 24·77, copper 32·91, silver 3·09, lead 0·04, zinc 6·40, iron 1·31, cobalt 0·49, stony matter 1·29, arsenic traces. Is found in Wermskog in Wermland in Sweden.

BRONGNIARDITE.—(Damour. Annales de Mines. t. xvi. 1849. 227.) Fracture uneven. No cleavage observed. Lustre metallic. Streak blackish-grey. H above 3. G = 5·950. In the matrass decrepitates, fuses and yields a slight orange sublimate in the lower part, and a white sublimate above. In the open tube emits fumes of sulphur, and deposits a white sublimate of oxide of antimony. Before the blowpipe on charcoal melts below redness, emits the odour of sulphur and white fumes, and leaves a globule of silver surrounded by a yellow areola of oxide of lead. Partially decomposed by nitric acid. Soluble in a large quantity of boiling hydrochloric acid. $\overset{\prime}{Pb} + \overset{\prime}{Ag} + \overset{\prime\prime\prime}{Sb}$, sulphur 19·08, antimony 30·66, silver 25·65, lead 24·61. Mean of three analyses by Damour:—sulphur 19·24, antimony 29·77, silver 24·77, lead 24·91, copper 0·62, iron 0·26, zinc 0·36. Was found associated with pyrite in Mexico.

CUPREOUS BISMUTH.—Kupferwismutherz. In long prismatic crystals cleavable very distinctly in one direction parallel to the axis of the prism. Fracture uneven. Opaque. Lustre metallic. Steel-grey, lead-grey, tin-white. Streak black. Sectile. H = 3·5. G = 5·0. Analysis by Klaproth:—copper 34·66, bismuth 47·24, sulphur 12·58. Was found at Gallenbach and Neuglück near Wittichen in Baden.

CUPROPLUMBITE.—Has a distinct cleavage parallel to the faces of a cube. Opaque. Lustre metallic. Blackish lead-grey. Streak black. Rather sectile. H = 2·5. G = 6·408...6·428. According to a quantitative blowpipe analysis by Plattner, it consists of:—sulphide of lead 74·98, sulphide of copper (Cu^2S) 24·45, sulphide of silver 0·57. Occurs in Chile.

ENARGITE.—Prismatic. *a* 100, *b* 010, *c* 001, *m* 110. *bc* = 90° 0′, *ca* = 90° 0′, *ab* = 90° 0′, *mm′* = 81° 49′. Cleavage. *m*, perfect; *a*, *b*, distinct; *c*, indistinct. Fracture uneven. Lustre metallic. Black. Streak black. Brittle. H = 3. G = 4·430...4·445. When heated in the matrass decrepitates and yields a sublimate of sulphur, fuses into a globule below a red heat, and yields a sublimate of sulphurous acid and sulphide of arsenic. In the open tube gives off sulphurous acid and oxide of antimony. Before the blowpipe on charcoal emits fumes of sulphide of arsenic, and deposits a sublimate of arsenious acid, oxide of antimony, and oxide of zinc. After being roasted, it gives with borax the reactions of copper and iron. Analysis by Plattner:—sulphur 32·22, arsenic 17·60, antimony 1·61, copper 47·21, iron 0·57, zinc 0·23, silver 0·02. Is found abundantly in compact masses, containing sometimes crystalline druses, forming a vein in crystalline limestone, at Morococha, district of Jouli, in the Cordilleras of Peru.

BISMUTHIC SILVER.—Wismuthbleierz. Fracture uneven, fine-grained. Opaque. Lustre metallic. Light lead-grey. Acquires a dark tarnish by exposure. Soft. Sectile. Analysis by Klaproth:—silver, 15·0, lead 33·0, bismuth 27·0, iron 4·3, copper 0·9, sulphur 16·3. In delicate acicular and capillary crystals; massive; disseminated. Was found in gneiss in the Friedrich Christians mine at Schapbach in Baden.

BISMUTHIC COBALT is probably a mechanical mixture of bismuthine and smaltine. Analysis by Kersten:—cobalt 9·89, iron 4·77, bismuth 3·89, copper 1·30, nickel 1·11, arsenic 77·96, sulphur 1·02.

LONCHIDITE, G = 4·925...5·001, from Freiberg, Schneeberg and Cornwall, contains, according to Plattner:—iron 44·23, cobalt 0·35, copper 0·75, lead 0·20, sulphur 49·61, arsenic 4·40.

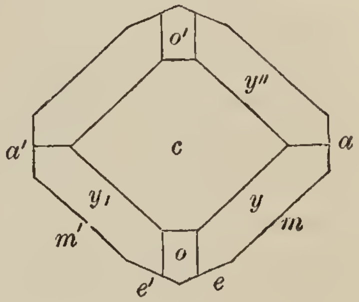
SHEPARDITE.—In small prisms. Opaque. Lustre metallic, imperfect. Brownish-black. Streak the same. H = 4·0. According to Shepard contains sulphur and chrome. Was found in small grains in the Bishopville meteorite.

ZUNDERERZ, from Andreasberg, Clausthal and Stolberg, consists of cherry-red or blackish-red capillary crystals interlaced so as to present flakes resembling tinder. Analysis by Bornträger:—silver 2·56, lead 43·06, iron 4·52, antimony 16·88, arsenic 12·60, sulphur 19·57.

YELLOW TELLURIUM.—The description by Phillips does not relate to the mineral of which he gives the figure, but probably represents some impure specimen of sylvanite. From an examination of some simple crystals taken from the specimen from which that figured by Phillips was obtained, we have ascertained that the angles approach so nearly to those of bournonite, as to lead to the conclusion that the crystals are that substance. The crystal figured by Phillips was probably a deceptive twin, of which the faces M, *f*, *a* belong to one individual, and the faces *c*, *e* to the other. The forms and angles of the crystals examined are:—*a* 100, *c* 001, *o* 011, *m* 110, *e* 120, *y* 111, *t* 112. *t* truncates the edge *yc*. Twins. Twin-face *m*.

ac	90°	0′	*ee′*	50°	12′
oc	43	23	*yo*	26	29
oo′	86	46	*yy′*	52	58
ma	46	52	*yy″*	49	24
mm′	86	16	*yc*	52	20
ea	64	54	*tc*	32	56

FIG. 641.



TENORITE.—In thin hexagonal or triangular scales. Translucent on the edges. Lustre metallic. Steel-grey...black. Brown by transmitted light. Streak black. CuO. Copper 79·82, oxygen 20·18. Is found in crevices in the lava of Vesuvius.

BOG IRON ORE.—Amorphous. Fracture conchoidal. Opaque. Lustre vitreous. Yellowish-brown...blackish-brown. G = 3·3...3·5. Analyses of bog iron ore *a* from Artana in Valencia by Proust, *b* from La Raquinerie by Berthier, *c* from Kempnow by Klaproth, *d* from New York by Kersten, *e* from

Leipzig by Erdmann, *f* from Amungen in Dalarne by Svanberg:—

	a	*b*	*c*	*d*	*e*	*f*
Red ox. iron	78·57	43·4	66·0	66·33	51·00	70·05
Protox. iron	—	—	—	3·60	—	—
Lime, magn.	—	—	—	—	—	2·43
Ox. mang.	—	15·0	1·5	0·75	—	1·78
Phosph. acid	—	—	8·0	0·12	10·99	0·34
Water, organ. acids .	21·43	15·0	23·0	26·40	28·80	15·87
Silica	—	23·0	—	2·80	9·20	8·03
Alumina	—	3·2	—	—	0·41	1·50

Bog iron ore is of recent formation, arising from the decomposition of certain rocks over which water passes, and is deposited in low and marshy situations. The variety called bohnerz or pea iron ore, occurs in small globular concretions. It is found in sandy plains, bogs and lakes in Lusatia, Lower Silesia, Brandenburg, Mecklenburg, Pomerania, Prussia, Poland, Lithuania, Russia, in the Highlands of Scotland, the Hebrides, Orkney and Shetland islands. A hydrous oxide of iron from the government of Nischnei-Nowgorod in Russia (quellerz) consists essentially of $\ddot{\overline{Fe}}\,\dot{H}^3$ according to Hermann.

ERDKOBALT. — Massive, disseminated, investing other minerals. Fracture earthy...flat conchoidal. Yellow, brown. Streak the same, paler, shining. Opaque. Sectile. H = 1·0... 2·5. G = 2·0...2·67. A mixture of hydrous arseniates of oxides of iron, cobalt and lime. Is found at Kamsdorf and Saalfeld in Thuringia, Riechelsdorf in Hessia, Allemont in Dauphiné.

GUMMIERZ. — Fracture conchoidal, uneven. Feebly translucent...opaque. Lustre resinous. Reddish-yellow...red. Streak yellow. Brittle. H = 2·5...3·0. G = 3·9...4·2. Before the blowpipe with borax fuses into a brownish-red bead which becomes yellow on cooling. With borax and salt of phosphorus forms a yellow glass in the outer flame, and a green glass in the inner flame. Analysis by Kersten:—yellow oxide of uranium 72·00, lime 6·00, oxide of manganese 0·05, phosphoric acid 2·30, silica 4·26, water 14·75, vanadic, arsenic and hydrofluoric acid traces. Is found at Johann-Georgenstadt in Saxony. Mr. Brooke has a specimen of which some small patches are black, resembling Uran pitch ore, and other parts, concentrically round the black in indistinct layers, are of a deep orange to pale yellow. These are probably an altered state of the black mineral, and may possibly be the substance here described.

KUPFERBLAU.—Amorphous. Fracture flat conchoidal.

Sky-blue. Streak shining. H = 4…5. G = 2·56. Yields water in the matrass. According to Plattner, it contains 45·5 per cent. of oxide of copper. Is found in the valley of Schapbach in Baden.

KUPFERMANGANSCHWÄRZE.—Amorphous. Fracture conchoidal. Opaque. Lustre resinous. Blueish-black. Streak the same. Slightly brittle. H = 3·5. G = 3·1…3·2. Analyses of compact kupfermanganschwärze *a* from Kamsdorf by Rammelsberg, *b* from Kamsdorf by Böttger, *c* from Schlackenwald by Karsten, *d* of an earthy variety from Lauterberg by du Menil:—

	a	*b*	*c*	*d*
Protox. mangan.	49·99	53·22	66·61	27·01
Oxygen	8·91	9·14	7·49	3·04
Black oxide of copper . .	14·67	16·85	4·80	11·51
Red oxide of iron	4·70	1·88	0·12	28·99
Barytes	1·64	1·70	—	—
Lime	2·25	2·85	—	—
Magnesia	0·69	gypsum	1·05	—
Oxides of cobalt and nickel .	0·49	0·14	—	—
Potash	0·52	0·65	—	—
Silica	2·74	—	0·30	—
Water	14·46	16·94	20·10	29·45

Is found at Kamsdorf, Schlackenwald, Lauterberg, Zellerfeld, Rheinbreitenbach, Kupferberg, Rudolstadt, Cornwall, the Banat, Schlangenberg in Siberia.

CHROMOCHRE.—Fracture earthy, uneven. Opaque or faintly translucent. Dull, sometimes feebly glistening. Green. It is usually so intimately mingled with other mineral substances, that it can only be separated from them by chemical operations. Analyses of substances coloured by oxide of chrome *a* from Creuzot by Drappiez, *b* from Waldenburg in Silesia by Zellner, *c* from Marlenberg in Dalarne in Sweden by Hisinger, *d* from Halle by Wolf:—

	a	*b*	*c*	*d*
Oxide of chrome	13·0	2·0	10	4·28
Oxide of iron	2·0	3·0	3	3·15
Silica	52·0	58·5	39	46·11
Alumina	27·0	30·0	36	30·53
Lime	4·5		soda	0·46
Potash	—	—	—	3·44
Water	—	6·25	8	12·52

Reniform, massive, investing other minerals. Is found in a conglomerate at Creuzot in France, in the porphyry of Elfdal in Sweden, Waldenburg in Silesia, Halle in porphyry by the decomposition of which it is produced.

PITCHY COPPER ORE is a mechanical mixture of limnite with a hydrous silicate of oxide of copper. According to v. Kobell, a variety from Turinsk consists of:—red oxide of iron 59·00, black oxide of copper 13·00, silica 9·66, water 18·00.

UMBER appears to be a mechanical mixture of limnite and hydrate of oxide of manganese and clay. Ferruginous red oxide of copper is a mixture of limnite with about 22 per cent. of red oxide of copper.

URANOCHRE.—Amorphous. Fracture earthy...imperfect conchoidal. Opaque. Dull...glimmering. Lemon-yellow... sulphur-yellow, brown. Soft, friable. In the matrass yields water and becomes red. Before the blowpipe in the inner flame becomes green without melting. With salt of phosphorus in the outer flame forms a yellow glass, in the inner flame a green glass. Easily soluble in acids. Probably oxide of uranium and water in unknown proportions. Occurs massive, disseminated, investing other minerals. Is found with pechuran, of the decomposition of which it is a product, with torberite, antunite, at Joachimsthal and Johann-Georgenstadt, and in metallic veins in granite at St. Symphorien in France.

VARVICITE.—Supposed to be decomposed manganite. In columnar and fibrous masses. Lustre metallic, imperfect. Iron-black...steel-grey. Streak black. H = 2·5...3. G = 4·5... 4·6. Analysis, from Warwickshire, by Phillips:—manganese 63·3, oxygen 31·7, water 5; from Ihlefeld by Duflos:—protoxide of manganese 81·41, oxygen 13·47, water 5·13.

ADINOLE is a mechanical mixture of albite and quartz found at Sahla and in the Harz. H = 6·5. G = 2·617...2·640. Analyses of adinole from Lerbach in the Harz by Schnedermann:—silica 71·60, alumina 14·75, soda 10·06, potash 0·32, lime 1·06, red oxide of iron with traces of protoxide of manganese 1·41.

ÆGYRINE. — Probably isomorphous with augite. *a* 100, *b* 010, *m* 110. $ma = 46° 34'$, $mb = 43° 26'$, $mm' = 86° 52'$. Cleavage. *a*, *b*, *m*. Greenish-black...blackish-green. Streak greenish-grey. H = 5·5...5·75. G = 3·432...3·504. Is found with leucophane in the island of Skaadön near Brevig.

ANDESINE is a mineral greatly resembling albite. With amphibole it constitutes a rock which occurs in the Andes, to which the name andesite has been given. The crystals of andesine resemble albite. The cleavage of andesine is not so distinct as that of albite. G = 2·7328. Andesine fuses as readily as oligoclase. Saccharite is probably a partially decomposed andesine. Cleavable distinctly in one direction. Fracture splintery, uneven. Translucent on the edges. Lustre vitreous, inclining to pearly. White, greenish-white, apple-green. Very brittle. H = 5·0...6·0. G = 2·66...2·69. Fuses before the blowpipe on the sharpest edges only. Imperfectly decomposed by hydrochloric and sulphuric acids. Is found in veins in serpentine on the Gläsendorf near Frankenstein in Silesia. Analyses *a* of andesine from the Andes by Abich, *b* wax-coloured, from the syenite of the Ballon de Servance in the Vosges, *c* coral-red, from Coravillers in the Vosges, both by Delesse, *d* of saccharite by C. Schmidt, *e* of a mineral resembling albite from Pisoje near Popayan by Francis:—

	a	*b*	*c*	*d*	*e*
G	2·7328	2·683	2·651	—	2·64
Silica	59·66	58·92	58·91	58·93	56·72
Alumina	24·28	25·05	24·59	23·50	26·52
Red oxide of iron . .	1·58	trace	0·99	—	0·70
Oxide of nickel . . .	—	—	—	0·39	—
Lime	5·77	4·64	4·01	5·67	9·38
Magnesia	1·08	0·41	0·40	0·56	—
Soda	5·63	7·20	7·59	7·42	6·19
Potash	1·08	2·06	2·53	0·05	0·80
Water	—	1·27	0·98	2·21	—

AURALITE.—In prisms. Black. Is found at Abo.

BARALITE.—Black slate with cavities filled with a black powder. A silico-aluminate of iron. Is found at Baralon, Coté du Nord, France.

BAULITE.—Oblique. Transparent. White. G = 2·656. In very thin splinters melts before the blowpipe into a clear glass. Analysis by Genth:—silica 80·23, alumina 11·71, lime 1·20, soda 2·26, potash 4·92. Is found in the matter ejected by Krabla in Iceland. The name baulite was first given by Forchammer to a greyish-white porous mineral from the Baula mountain in Iceland, having nearly the same composition as the crystals analyzed by Genth, but sometimes containing also 2...3 per cent. of water.

BUSTAMITE is a cleavable variety of rhodonite from Real de Minas de Fetela in Mexico, containing a large quantity of lime. Columnar, radiating. Greenish-grey, reddish-grey. H = 5·5. G = 3·12...3·23. According to Dumas contains:—silica 48·90, protoxide of manganese 36·06, lime 14·57, protoxide of iron 0·81. Photizite, hydropite, hornmangan, diaphorite, allagite are mechanical mixtures of rhodonite, with quartz and diallogite.

BOLTONITE. — (Shepard.) Granular. Cleavage in one direction distinct; in two other directions less distinct. Fracture uneven...small conchoidal. Lustre vitreous. Blueish-grey, yellowish-grey, yellow, white. H = 5·5. G = 3·008. Analysis by B. Silliman:—silica 46·06, alumina 5·67, magnesia 38·15, protoxide of iron 8·63, lime 1·52. Is found massive in a limestone quarry at Bolton in Massachusetts.

BREISLAKITE occurs in delicate capillary crystals. Translucent. Lustre imperfect metallic. Yellowish, reddish, chesnut-brown. Fusible before the blowpipe into an iron-black, magnetic slag. Is found in felt-like aggregations of crystals, in cavities of lava at Viterbo on Capo di Bove near Rome, and in some other parts of Italy.

BYTOWNITE, from Bytown in Canada, according to the analysis by T. S. Hunt, is christianite. Greenish-white. H = 6·5. G = 2·732...2·733. Silica 47·40, alumina 30·45, lime 14·24, magnesia 0·87, protoxide of iron 0·80, soda 2·82, potash 0·38, water 2·00. The amount of water renders it probable that the mineral was partially decomposed.

CORUNDELLITE. — (B. Silliman. Silliman's Journal. 1849. 8. 380.) In broad foliated masses of a yellowish-white colour, easily cleavable, and apparently hexagonal. Inelastic, brittle. H = 3·5. G = 3·0. Analysis by I. J. Crooke:—silica 35·71, alumina 53·13, lime 7·27, potash 1·22, soda 0·41, water and fluorine 2·30. Is found in foliated masses and scales disseminated through corundum at Unionville in Pennsylvania.

COUZERANITE.—This mineral, as noticed by Mr. Brooke in the Phil. Mag. for August, 1831, is described in Leonhard's Handbuch on the authority of Charpentier as a right rectangular prism, and by M. Dufresnoy in the Ann. de Chim. v. 38, p. 280, as an oblique rhombic prism. Is found in the valleys of Seix and Salaix, the Col de la Trappe and the Picou de Gen, in Les Couzerans in the Pyrenees.

DANBURITE.—$pm = 70^\circ$, $mt = 54^\circ$, $ep = 45^\circ$, $et = 42^\circ$. t, e, p are in one zone. Cleavage. m, p, distinct; t, less distinct. Translucent. Lustre vitreous. Pale yellow. Analysis by H. Erni:—silica 49·74, lime 22·80, magnesia 1·98, soda 9·82, potash 4·31, alumina and red oxide of iron 2·11, boracic and loss 9·24. Is found at Danbury in Connecticut.

DIPYRE occurs in regular hexagonal prisms, imbedded in a grey soft matrix. Is found at Mauleon in the Pyrenees.

EUKOLITE.—Like wöhlerite. Reniform. Brown. G = 3·01. Melts easily with ebullition into a green glass. Is decomposed by hydrochloric acid. Analysis by Scheerer:—silica 47·85, tantalic acid and zirconia 14·05, red oxide of iron 8·24, protoxide of manganese 1·94, lime 12·06, protoxide of cerium 2·98, soda 12·31, water 0·94. Is found in the zircon-syenite near Brevig.

GLAUCOLITE.—Cleavage, not very perfect, in two directions making with each other an angle of nearly 36° 30′. Fracture splintery, uneven. Translucent on the edges. Lustre vitreous, inclining to pearly on the cleavage faces. Lavender-blue, green. Streak light grey. H = 5·0…6·0. G = 2·65…2·9. Before the blowpipe becomes white and fuses only on the edges. Soluble with difficulty in borax and salt of phosphorus. Is found near lake Baikal in Siberia in veins in granite, and also, it is said, with elæolite near Laurvig in Norway. Analyses of glaucolite from the Baikal *a* by Bergemann, *b* by Giwartowski, *c* of a mineral from Pargas, supposed by Frankenheim to be labradorite, by Nordenskiöld, *d* of silicite from Antrim by Thomson:—

	a	*b*	*c*	*d*
Silica	50·58	50·49	54·13	54·8
Alumina	27·60	28·13	29·13	28·4
Red oxide of iron	0·10	0·40	(Ḟe	4·0)
Oxide of manganese	0·87	0·59	—	—
Lime	10·27	11·31	15·46	12·4
Magnesia	3·73	2·68	—	—
Soda	2·97	3·10	—	—
Potash	1·27	1·01	—	—
Water	—	1·79	1·07	0·6

AMPHODEDITE, LEPOLITE, and Bournon's **INDIANITE** are probably christianite. The crystals of amphodelite greatly resemble those of christianite, and appear to consist of numerous crystalline laminæ arranged as twins. The angles which have been observed are:—$pm = 94^\circ\ 20'$, $pa = 64^\circ\ 0'$, $py = 81^\circ$ nearly, $ya = 145^\circ$ nearly. y, c, a are in the same zone. Cleavage. c, b, perfect; the cleavage c is interrupted by striæ where it intersects the junctions of the twin crystals. Translucent on the edges. Lustre vitreous. Reddish-grey...peach-blossom red. H = 5·5...6·0. G = 2·763. Melts before the blowpipe into a colourless blebby glass. With borax fuses slowly into a transparent bead. Is found in granular limestone at Lojo in Finland, Tunaberg in Sweden and Bytown in Upper Canada. The crystals of lepolite are said to resemble those of oligoclase. G = 2·75...2·77. Melts with difficulty before the blowpipe into a transparent glass. In very fine powder is soluble in mineral acids. Indianite has two cleavages making with each other an angle of 94° 15′. More or less translucent. White, grey, red. H = 7·0...7·25. G = 2·668...2·742. Said to be infusible before the blowpipe. Gelatinizes with acids. Indianite is the matrix of corundum in India. Analyses of amphodelite *a* from Lojo by Nordenskiöld, *b* from Tunaberg by Svanberg, of lepolite *c* from Lojo, *d* from Orijerfvi, both by Hermann, *e*, *f* of indianite by Laugier, *g* of indianite, H = 7·0...7·25, G = 2·668, by Brush:—

	a	*b*	*c*	*d*	*e*	*f*	*g*
Silica	45·80	44·55	42·80	42·50	42·00	43·0	42·09
Alumina . .	35·45	35·19	35·12	33·11	34·00	34·5	38·89
Red ox. iron .	1·70	0·07	1·50	4·00	3·20	1·0	—
Lime	10·15	15·02	14·94	10·87	15·00	15·6	15·78
Magnesia . .	5·05	4·08	2·27	5·87	—	—	—
Soda	—	—	1·50	1·69	3·35	2·6	4·08
Water	1·85	0·59	1·56	1·50	1·00	1·0	—

LOXOCLASE. — Oblique. Has the faces *a* cleavage, *b*, *c*, *x*, *y*, *m*, of felspar. $ab = 90^\circ\ 0'$, $cb = 90^\circ\ 0'$, $ac = 63^\circ\ 38'$, $xa' = 65^\circ\ 37'$, $yc = 80^\circ\ 15'$. Cleavage. c, very perfect; b, very distinct; a, indistinct. Fracture uneven...conchoidal...splintery. Translucent. Lustre vitreous, inclining to resinous; on c pearly. H nearly 6. G = 2·609...2·620. Analysis by Plattner:—silica 63·50, alumina 20·29, red oxide of iron 0·67, potash 3·03, soda 8·76, lime 3·22, magnesia trace, water and fluosilicic acid 1·23. Loxoclase appears to have the chemical constitution of oligoclase with the form of felspar. Is found with graphite, calcite and diopside at Hammond in New York.

COMPACT FELSPAR, PITCHSTONE, PEARLSTONE, OBSIDIAN, PUMICE.—The first of these amorphous substances appears to be a mechanical mixture of felspar and quartz; the others probably result from their fusion with each other, and, possibly, with other substances. 1. Compact felspar.—Fracture splintery...conchoidal. Translucent...translucent on the edges. Dull. White, grey, red. H = 6 or more. G = 2·59...3·0. Fusible with difficulty before the blowpipe into a white enamel. Is found in the gneiss of Sweden where it is called hälleflinta, in Saxony and Bavaria (weissstein), the Harz, the neighbourhood of Halle, the Thüringer Wald, the mining districts of Saxony, Silesia, Bohemia, the Tyrol. 2. Pitchstone.—Fracture conchoidal, splintery, uneven. Feebly translucent...opaque. Lustre resinous, inclining to vitreous. Grey, green, yellow, red, brown, black. H = 5·5...6·0. G = 2·2...2·3. Melts with intumescence before the blowpipe into a blebby glass. Is found near Meissen, Zwickau and other places in Saxony, Auvergne, Newry in Ireland, Siberia, Iceland, Mexico, Peru, the Scottish islands. 3. Pearlstone.—Fracture small conchoidal. Translucent on the edges...opaque. Lustre pearly, inclining to waxy. Grey, yellow, red, brown. H = 6·0. G = 2·25...2·38. Intumesces violently before the blowpipe, forming a white, spongy slag. Is found in globules and grains at Schemnitz, Tokay and Telkebanya in Hungary, Cabo de Gata in Spain, Ochotzk in Siberia, Mexico. 4. Obsidian and pumice appear to differ only in their state of aggregation. Obsidian has a perfect conchoidal fracture; is semi-transparent...translucent on the edges; has a vitreous lustre; is black, grey, green or brown. H = 6·0...7·0. Pumice is porous or fibrous; has a small conchoidal fracture; is translucent...translucent on the edges; has a vitreous lustre, inclining to resinous; is white, grey, brown, black. H = 5·0. Obsidian and pumice melt before the blowpipe, with intumescence, into a glass full of bubbles. Obsidian is found in Iceland, Mexico, the Azores, Teneriffe, Ascension, the Lipari islands, Milo, Santorin, in Hungary at Schemnitz, Glashütte, Tokay, Eperies, in small balls and grains at the mouth of the Marekanka. Pumice occurs alone, or containing crystals of glassy felspar, above obsidian in streams of lava and in volcanic conglomerates. It is found at Neuwied on the Rhine, in the Lipari islands, forming the mass which covers Pompeii, Milo, Santorin, Teneriffe, the Azores, Iceland, Mexico, Columbia, Hungary, Auvergne. Analyses of petrosilex *a* from Nantes by Berthier, *b* of weissstein from the Pacheralp by Klaproth, *c* of pitchstone from Meissen by Erdmann, *d* from Newry by Knox, *e* of pearlstone from Tokay by Klaproth, *f* from Hlinick in Hungary by Erdmann:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	75·20	79·00	75·60	72·80	72·25	72·87
Alumina	15·00	11·50	11·60	11·50	12·00	12·05
Potash	3·40	6·00	—	—	4·50	6·13

	a	*b*	*c*	*d*	*e*	*f*
Soda	—	—	2·77	2·87	—	—
Lime	1·20	—	1·35	1·12	0·50	1·30
Magnesia	2·40	—	6·69	—	—	1·10
Oxide of iron	—	1·25	1·20	(Ḟe 3·03)	1·60	1·75
Water & vol. mat.	1·50	1·00	4·73	8·50	4·50	3·00

Analyses of obsidian *g* from Telkebanya by Erdmann, *h* of a nodule which, when cut into by a lapidary's wheel, burst with a loud explosion, by Damour, *i* from the Bay of Islands in New Zealand, G = 2·386, *k* from Ascension, both by Murdoch, *l* from Moldauthein in Bohemia by Erdmann, *m* from Java by van der Boon Mesch :—

	g	*h*	*i*	*k*	*l*	*m*
Silica	74·80	70·34	75·20	70·97	82·70	79·40
Alumina	12·40	8·63	6·86	6·77	9·40	11·25
Red ox. iron	2·03	(Ḟe 10·52)	6·54	6·24	2·61	4·30
Protox. mangan.	1·31	0·32	—	—	1·30	—
Lime	1·96	4·56	3·83	2·84	1·21	1·75
Magnesia	0·90	1·67		1·77	1·21	—
Soda	—	3·34	7·57	11·41	2·45	3·03
Potash	6·40	—			—	—

Analyses of obsidian *n* from Teneriffe, *o* of pumice from Teneriffe, *p* of pumice from the island of Ferdinandea, *q* pumice from the volcano of Arequipa, *r* pumice from Ischia, *s* obsidian from Procida, *t* pumice from the Phlegrean fields, *u* pumice from Pantellaria, *v* pumice from Santorin, *w* pumice from Llactacunga at the foot of Cotopaxi, *x* pumice from Lipari, *y* obsidian from Lipari, all by Abich :—

	n	*o*	*p*	*q*	*r*	*s*
G	2·528	2·477	1·983	2·571	2·417	2·489
Silica	60·52	60·79	61·08	62·42	62·29	62·70
Silica and titan. ac.	0·66	1·46	1·45	0·74	—	—
Alumina	19·05	16·43	17·37	14·72	16·89	18·98
Red ox. iron	4·22	4·26	7·77	6·84	4·15	4·98
Oxide of mang.	0·33	0·23	0·62	0·18	trace	0·39
Lime	0·59	0·62	1·46	3·25	1·24	1·77
Magnesia	0·19	0·79	4·02	3·28	0·50	0·82
Soda	10·63	11·25	2·85	4·74	6·21	6·09
Potash	3·50	2·95	1·82	1·55	3·98	4·35
Chlorine	0·30	0·53	1·63	2·41	3·89	0·76
Water	0·04					0·52

	t	*u*	*v*	*w*	*x*	*y*
G	2·411	2·53	2·354	2·224	2·377	2·370

	t	*u*	*v*	*w*	*x*	*y*
Silica	62·04	68·11	69·79	73·77	73·70	70·05
Silica & titan. acid .	—	1·23	—	—	—	—
Alumina	16·55	8·21	12·31	10·83	12·27	12·97
Red ox. iron . . .	4·43	8·23	4·66	1·80	2·31	2·73
Lime	1·31	0·14	1·68	1·21	0·65	0·12
Magnesia	0·72	0·37	0·68	1·30	0·29	0·28
Soda	6·39	8·32	6·69	4·29	4·52	4·15
Potash	3·66	1·60	2·02	3·90	4·73	5·11
Chlorine	3·84	0·70	2·93	2·85	0·31	0·31
Water		1·73			1·22	0·22
Carburetted hydrog.	—	0·66	—	—	—	—

HETEROKLINE.—Oblique. *mm'* = 51° 44'. Lustre metallic, imperfect. Iron-black. Streak black, inclining to brown. H = 5. G = 4·652. Analysis by Ewreinoff:—silica 10·30, oxide of manganese 85·86, red oxide of iron 3·72, lime 0·62, potash 0·44. Is found at St. Marcel in Piedmont.

HYALOMELAN.—Amorphous. Fracture conchoidal...uneven. Opaque. Lustre vitreous, inclining to resinous. Black. Streak dark grey. Brittle. H = 6·5. G = 2·7144. Before the blowpipe melts very readily into an opaque glass. With borax fuses into a transparent glass. With salt of phosphorus fuses into a bead which becomes faintly violet in the inner flame. Is completely decomposed by hydrochloric acid. Analysis by C. Gmelin:—silica 50·22, alumina 17·84, lime 8·25, magnesia 3·37, protoxide of iron 10·27, protoxide of manganese 0·40, soda 5·18, potash 3·87, titanic acid 1·41, ammoniacal water 0·50. Is found in nodules in a volcanic rock at Babenhausen in the Vogelsgebirge.

HYPOCHLORITE. — Fracture even...flat conchoidal. Translucent...opaque. Lustre vitreous, feeble. Green. Streak light green. Brittle. H = 6·0. G = 2·9...3·0. Grows dark before the blowpipe, but does not melt; deposits a yellow sublimate upon the charcoal. Insoluble in acids. Analysis by Schüler:—silica 50·24, alumina 14·65, oxide of bismuth 13·03, protoxide of iron 10·54, phosphoric acid 9·62, manganese traces. Is found in indistinct microscopic crystals, massive, disseminated and earthy, at Schneeberg, Johann-Georgenstadt and Bräunsdorf in Saxony.

ISOPYRE. — Amorphous. Fracture conchoidal. Opaque ...translucent on the edges. Lustre vitreous. Black. Streak greenish-grey. Brittle. H = 5·5...6·0. G = 2·912. Feebly magnetic. Analysis by Turner:—silica 47·09, alumina 13·91, red oxide of iron 20·07, lime 15·43, oxide of copper 1·94. Is found in granite at St. Just near Penzance in Cornwall, and Calton Hill near Edinburgh.

JEFFERSONITE.—An augite containing some oxide of zinc. G = 3·31...3·5. Melts on the edges into a black slag. Analysis by Hermann:—silica 49·91, alumina 1·93, protoxide of iron 10·53, protoxide of manganese 7·00, lime 15·48, magnesia 8·18, oxide of zinc 4·39, loss by ignition 1·20. Is found at Franklin in New Jersey.

KEILHAUITE.—Cleavage in one direction, distinct; traces in two other directions. Fracture small conchoidal...uneven. Translucent. Lustre, on the plane of perfect cleavage vitreous, on the surfaces of fracture resinous. Brownish-black; by transmitted light brownish-red. Streak light greyish-brown. H = 6·5. G = 3·69. Before the blowpipe melts easily with ebullition into a bright black slag. Soluble in borax, to which it imparts the colour of iron. In the inner flame the bead becomes blood-red. With soda shows the presence of manganese. In fine powder is completely decomposed by hydrochloric acid. Analyses by Erdmann:—

Silica	30·00	24·45
Titanic acid	29·01	28·14
Alumina	6·09	5·90
Red oxide of iron . . .	6·35	6·48
Oxide of manganese . .	0·67	0·86
Oxide of cerium . . .	0·32	0·63
Yttria	9·62	9·74
Lime	18·92	18·68

Is found massive in Buön not far from Arendal in Norway.

KNEBELITE.—Fracture imperfect conchoidal. Opaque. Glimmering...dull. Grey, green, brown. G = 3·714. Infusible. With borax melts into a dark olive-green glass. Is readily decomposed by hydrochloric acid. Compact. $\dot{Fe}^2\dddot{Si} + \dot{Mn}^2\dddot{Si}$. Analysis by Döbereiner:—silica 32·5, protoxide of manganese 35·0, protoxide of iron 32·0.

LEPIDOMELANE.—In six-sided prisms. Cleavage, parallel to the base of the prism, perfect. Opaque. Lustre vitreous, inclining to adamantine. Black, in very thin scales green by transmitted light. Streak mountain-green. Rather brittle. H = 3·0. G = 3·0. Before the blowpipe melts into a black magnetic enamel. Easily soluble in borax forming a bottle-green glass. Is decomposed by hydrochloric and nitric acids, leaving the silica in pearly scales. Analysis by Soltmann:—silica 37·40, alumina 11·60, red oxide of iron 27·66, protoxide of iron 12·43, magnesia and lime 0·60, potash 9·20, water 0·60. Is said to have been found at Persberg in Wermland.

MARGARODITE.—A mineral resembling mica, from the Greiner. G = 2·87. Analysis by Schafhäutl:—silica 47·05, alumina 34·90, red oxide of iron 1·50, magnesia 1·95, potash 7·96, soda 4·07, water 1·45.

MUROMONTITE.—Lustre vitreous. Slightly translucent. Black. Streak grey. H = 7. G = 4·265. Glows before the blowpipe. Slightly fusible on the edges. Is decomposed by acids, leaving a jelly of silica. Analysis by Kerndt:—silica 31·09, alumina 2·24, glucine 5·52, yttria 37·14, protoxide of iron 11·23, protoxide of manganese 0·91, protoxide of cerium 5·54, oxide of lanthanium 3·54, magnesia 0·42, lime 0·71, soda 0·65, potash 0·17, water and loss 0·85. Is found in small grains with bodenite in oligoklas at Boden near Marienberg in Saxony.

MALACONE and OERSTEDITE are names given to two minerals having the form of zircon. No cleavage has been observed in either of them. Perhaps they are zircon in different stages of decomposition, or of metasomatic change. These substances have been described as follows:—Malacone.—Fracture conchoidal. Lustre vitreous. Internally milk-white, inclining to grey. H = 6·0. G = 3·903...3·913. Heated quickly to redness phosphoresces slightly, after which G = 4·22. Infusible before the blowpipe. In fine powder slightly soluble in borax and salt of phosphorus. In fine powder decomposed by digestion in heated sulphuric acid. Analysis by Scheerer:—silica 31·31, zirconia 63·40, red oxide of iron 0·41, yttria 0·34, lime 0·39, magnesia 0·11, water 3·03. Is found at Hitteröe in Norway. Oerstedite.—Translucent. Lustre adamantine, inclining to vitreous. Yellowish-brown. H = 5·5. G = 3·629. In the matrass yields water. Infusible before the blowpipe. With borax melts with difficulty into a colourless glass. Analysis by Forchammer:—silica 19·71, titanic acid and zirconia 68·96, magnesia 2·05, lime 2·61, protoxide of iron 1·14, water 5·53. Is found at Arendal in Norway with uralite and sphene. There are some pale yellowish-brown pyramidal crystals from Brazil in Mr. Brooke's cabinet, having the form and measurement of zircon, and the appearance of being either partially decomposed or pseudomorphous. They formed part of the collection sent by Captain Lyon to this country, and have not, that we are aware of, been analyzed.

NEPHRITE, according to Damour, is compact augite. Fracture splintery. Translucent...translucent on the edges. Lustre resinous, glimmering...dull. Leek-green...greenish-white, greenish-grey. Streak white, shining. Tough. H = 5·5...6·0. G = 2·65...3·0. Slightly unctuous to the touch. Before the blowpipe whitens and melts with difficulty into a grey mass. Analysis *a* by Rammelsberg, *b*, *c* by Schafhäutl, *d*, *e* by Damour:—

	a	*b*	*c*	*d*	*e*
Silica	54·68	58·91	58·88	58·46	58·02
Magnesia	26·01	22·42	22·39	27·09	27·19
Lime	16·06	12·28	12·15	12·06	11·82
Protox. iron	2·15	—	—	1·15	1·12
Red ox. iron	—	2·70	2·81	—	—
Protox. mangan. . .	1·39	0·91	0·82	—	—
Alumina	—	1·32	1·56	—	—
Potash	—	0·80	0·80	—	—
Water	0·68	0·25	0·27	—	—

Is found massive, in solitary blocks, in the alum earth at Schwemmsal near Leipsig, Turkey, Little Thibet, the Himalaya Mountains, Ellora, China, Egypt, the river Amazon.

NORDENSKIÖLDITE.—Resembles wollastonite or tremolite. Is found in granular limestone at Ruskula on the Onega lake in Russia.

ORANGITE.—(Orangit, Krantz. Poggendorff's Annalen. April, 1851.) Cleavable in one direction. Fracture conchoidal...splintery. Translucent...transparent. Orange. Streak yellowish-white. H = 4·5. G = 5·34...5·397. In the matrass yields water and becomes dark brown, but on cooling regains the orange colour. Infusible before the blowpipe. By fusion with soda the silica is dissolved, leaving insoluble yellow fragments in the bead. With borax forms a glass which is yellow while hot, but colourless when cold. With salt of phosphorus in the outer flame yields a reddish glass, in the inner flame a yellowish glass. The glass in either case is colourless when cold. With hydrochloric acid forms a perfectly clear, deep yellow jelly. After exposure to a strong red heat is not acted upon by acids. The quantities of oxygen in the silica, oxide of donarium and water are as the numbers 3, 3, 2. Analysis by C. Bergemann:—silica 17·70, oxide of donarium 71·25, carbonate of lime 4·04, red oxide of iron 0·31, magnesia and oxide of manganese 0·21, potash with a little soda 0·30, water 6·90. According to Damour, the substance called oxide of donarium is impure thorine. Is found in cleavable and compact masses, imbedded in felspar, in Langesundfjord near Brevig in Norway.

PIHLITE, from Brattstadt near Sahla, according to Svanberg, consists of:—silica 63·68, alumina 25·12, red oxide of iron 3·01, magnesia 1·52, potash 3·76, water 2·39, fluorine 0·84, magnesium 1·24.

POLYLITE.—In plates. Structure lamellar. Cleavage single. Opaque. Lustre vitreous. Black. H = 6·0...6·5. G = 3·231. Analysis by Thomson:—silica 40·04, protoxide of iron 34·08, protoxide of manganese 6·60, alumina 9·43, lime 11·54, water 0·40. Is found in magnetite at Hoboken in New Jersey.

SAUSSURITE is supposed to be impure labradorite. Sometimes cleavable in two directions, making with each other an angle of 124°. Fracture splintery...uneven. More or less translucent on the edges. Dull, sometimes glimmering. Greyish-white, green, grey. Extremely tough. H = 6·0. G = 2·69...3·4. Before the blowpipe fuses with difficulty into a greenish or greyish-white enamel. Analyses of saussurite *a* from the lake of Geneva by Saussure, *b* from the lake of Geneva, *c* from Siebenlehn near Freiberg, both by Klaproth, *d* from Mount Genèvre, *e* from the valley of Orezza in Corsica, both by Boulanger:—

	a	*b*	*c*	*d*	*e*
Silica	44·00	49·00	51·00	44·6	43·6
Alumina	30·00	24·00	30·50	30·4	32·0
Red oxide of iron . . .	12·50	6·50	1·75	—	—
Oxide of manganese . .	0·05	—	—	—	—
Lime	4·00	10·50	11·25	15·5	21·0
Magnesia	—	3·75	—	2·5	2·4
Soda	6·00	5·50	4·00	7·5	—
Potash	0·25	(water	1·25)	—	1·6

With augite and amphibole it constitutes the rocks called gabbro and euphotide. It is found on Mont Rosa, the Bacher Mountain in Stiria, Wurlitz in Baireuth, Corsica, Greenland, Madras, the Harz, and in boulders on the shores of the lake of Geneva.

SESQUISLICATE of MANGANESE appears to be a manganesian amphibole. Cleavage in two directions, making with each other angles of 56° 30′ and 123° 30′. Lustre vitreous.

Brown. H = 6·0. G = 3·58. Analysis by Thomson:—silica 42·40, protoxide of manganese 50·72, protoxide of iron 6·76. A granular mineral, called in America bisilicate of manganese, is also supposed to be a manganesian amphibole. Translucent on the edges. Lustre vitreous. Rose-red. H = 6·0. G = 3·42. Not decomposed by acids. Analysis by Hermann:—silica 48·91, protoxide of manganese with traces of protoxide of iron 46·74, lime 2·00, magnesia 2·35.

SKOLOPSITE.—A compact grey, white or reddish mineral found on the Kaiserstuhl in Baden. H = 5. G = 2·53. Melts before the blowpipe with intumescence into a bright, greenish-white globule. Is readily decomposed by hydrochloric acid, forming a jelly. Analysis by v. Kobell:—silica 44·06, alumina 17·86, red oxide of iron with some protoxide of iron 2·49, protoxide of manganese 0·86, lime 15·48, magnesia 2·23, soda 11·54, potash 1·30, sulphuric acid 4·09, chloride of sodium 0·93, sulphur a trace.

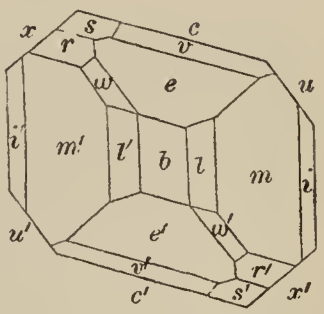
STROGANOWITE.—Cleavage in two directions, making with each other an angle of nearly 90°. Fracture uneven. Semi-transparent...translucent. Lustre, on the cleavages vitreous, inclining to resinous, bright; on the surface of fracture glimmering. Light green. H = 5. G = 2·79. In powder soluble in hydrochloric acid, with evolution of carbonic acid, leaving silica in powder. Analysis by Hermann:—silica 40·58, alumina 28·57, lime 20·20, soda 3·50, protoxides of iron and manganese 0·89, carbonic acid 6·40. Is found in crystalline masses in loose blocks on the river Sljudenka in Dauria.

TACHYLITE.—Amorphous. Fracture conchoidal...uneven. Opaque. Lustre vitreous, sometimes inclining to resinous. Black. Streak dark ash-grey. Brittle and very fragile. H = 6·5. G = 2·565...2·593. In powder and in small fragments attractable by the magnet. Before the blowpipe melts easily into an opaque brownish-green magnetic glass. With salt of phosphorus melts into a glass which is yellow and transparent while hot, but becomes opaque on cooling, and in the inner flame assumes a pale violet colour. Is completely decomposed by hydrochloric acid. Analysis of tachylite from Säsebühl by Schnedermann:—silica 55·74, alumina 12·40, black oxide of iron 13·06, lime 7·28, magnesia 5·92, soda 3·88, potash 0·60, protoxide of manganese 0·19, water 2·73. Was found coating the surface of basalt on the Säsebühl near Dransfeld between Göttingen and Münden, and coating the cavities in the basalt of Höllengrund near Münden.

TURNERITE.—Oblique. *a* 100 cleavage, *b* 010, *c* 001, *e* 011, *v* 012, *o* 021, *u* 101, *x* $\bar{1}01$, *m* 110, *i* 210, *l* 120, *z* 111, *r* $\bar{1}11$, *s* $\bar{1}13$, *w* $\bar{1}21$. *a* is common to the zones *ux′*, *mb*; *z* is common to the zones *mc*, *ub*; *o* is common to the zones *bc*, *lx*. The angles, according to the observations of Phillips and Levy, are:—

uc	37°	31′	*sc*	26°	8′
xc	52	25	*rc*	60	30
ob	27	48	*wb*	33	50
eb	47	22	*zb*	59	38
vb	65	17	*rb*	53	30
cb	90	0	*xb*	90	0
lb	29	5	*wc*	69	49
mb	48	5	*mm′*	96	10
ib	65	55	*rm′*	39	10
zc	46	10	*sm*	73	32
mc	80	20	*wm′*	35	9

FIG. 642.



Cleavage. *a*, *b*. Translucent...transparent. Yellowish-brown. Hardness 4·0...5·0. According to Children, contains alumina, lime, magnesia and very little silex and iron. Has been found only on Mont Sorel in Dauphiné with quartz, felspar, crichtonite and anatase.

CHLORITOIDE.—Analyses *a*, *b* by Erdmann, *c* by Gerathewohl :—

	a	*b*	*c*
Silica	24·90	24·96	24·40
Alumina	46·20	43·83	45·17
Protoxide of iron . .	28·89	31·20	30·29

According to G. Rose, the substance analyzed by v. Bonsdorff is the true chloritoide or masonite.

VOSGITE.—(Delesse.) A green felspathic mineral from the porphyry of Ternuay in the Vosges, subject to decomposition when exposed to the weather. Analyses *a* of vosgite from Ternuay, *b* of a felspathic mineral from the globular diorite of Corsica, also called vosgite by Delesse, but which Rammelsberg supposes to be labradorite, of a decomposing labradorite, *c* from the porphyry of Belfahy in the Vosges, *d* from the porphyry of the south of the Morea, all by Delesse :—

	a	*b*	*c*	*d*
G	2·771	2·737	2·719	2·8823
Silica	49·32	48·62	52·89	53·20
Alumina	30·07	34·66	27·39	27·31

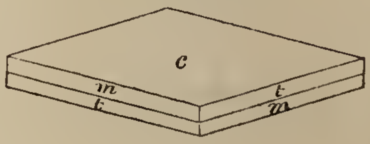
	a	*b*	*c*	*d*
Red oxide of iron	0·70	0·73	1·24	1·03
Protoxide of manganese	0·60	—	0·30	—
Magnesia	1·96	0·33	—	1·01
Lime	4·25	12·02	5·89	8·02
Soda	4·85	2·55	5·29	3·52
Potash	4·45	1·05	4·58	3·40
Water	3·15	0·50	2·28	2·51

WEHRLITE is probably ilvaite. Lustre on surface of fracture imperfect metallic. Iron-black, inclining to green. Streak greenish-grey. H = 6·2. G = 3·90. Slightly magnetic. Fusible with difficulty before the blowpipe. Imparts the colour of iron to borax. Imperfectly decomposed by hydrochloric acid. Analysis by Wehrle:—silica 34·60, red oxide of iron 42·38, protoxide of iron 15·78, oxide of manganese 0·28, lime 5·84, alumina 0·12, water 1·00. Is found in granular masses on the Kecskefar mountain near Szutraskö in the county of Zemesch in Hungary.

XENOLITH.—Is found in pebbles with wörthite at Peterhoff in Russia. Analysis by Komonen:—silica 47·44, alumina 52·54.

ZYGADITE.—Oblique? In thin tabular twin crystals. *m*, smooth; *t*, rough. Cleavage. *c*, very distinct. Fracture uneven. Feebly translucent. Lustre vitreous, on *c* inclining to pearly. Reddish-white, yellowish-white. H not quite 6. G = 2·511...2·512. According to Plattner, contains silica, alumina and lithia. Was found in very small crystals with quartz and chabasie in the Catharina Neufang mine at Andreasberg in the Harz.

FIG. 643.



APHRODITE.—A mineral from Langbanshytta greatly resembling meerschaum. G = 2·21. Analysis by Berlin:—silica 51·58, magnesia 34·07, protoxide of manganese 1·49, protoxide of iron 0·55, alumina 0·13, water 11·34.

ATHERIASTITE is probably an altered scapolite showing the faces *a*, *m*, *r*. The edges and angles are rounded. Cleavage. *m*, perfect. Fracture uneven, splintery, dull or glimmering. Analysis by Berlin:—silica 38·00, alumina 24·10, lime 22·64, magnesia 2·80, protoxide of iron 4·82, protoxide of manganese 0·78, water 6·95. Is found in the Näs mine near Arendal in a granitic rock with garnet and keilhauite.

BLACK CHALK.—Fracture slaty, earthy. Black. Streak black, shining. Opaque. Sectile. Soils. H = 1·0...1·5. G = 2·1...2·19. Analysis by Fuchs:—silica 57·59, alumina 12·92, red oxide of iron 0·87, magnesia 0·57, potash and soda 4·02, carbon 17·52, water 6·30. Is found in Italy, France, Spain, Portugal, England.

BODENITE.—In long crystals. Fracture conchoidal... uneven. Lustre vitreous, inclining to resinous. Brown... black. Streak greyish-white. Analysis by Kerndt:—silica 26·12, alumina 10·34, protoxide of iron 12·05, yttria 17·43, oxide of lanthanium 7·57, lime 6·32, magnesia 2·34, protoxide of manganese 1·62, potash 1·21, soda 0·84, water 3·82. Is found at Boden near Marienberg.

BOLE.—In nodules. Fracture conchoidal. Translucent on the edges...opaque. Brown of various shades. Streak resinous. Sectile. H = 1·5...2·5. G = 1·6...2·0. Analyses of bole *a* from Säsebühl by Wackenroder, *b* from Ettingshausen, *c* from the Cape of Prudelles, both by Löwig, *d* from Striegau by Zellner, *e* of 'fettbol' from Halsbrücke near Freiberg, G = 2·249, by Karsten:—

	a	*b*	*c*	*d*	*e*
Silica	41·26	42·00	41·05	42·00	46·40
Alumina	21·08	24·04	25·03	20·12	3·01
Red oxide of iron . .	12·08	10·03	8·09	8·53	23·50
Magnesia	1·39	0·43	0·50	2·01	—
Lime	0·38	0·52	0·45	2·81	—
Potash	0·13	—	—	0·50	—
Water	24·57	24·03	24·02	24·00	24·50

Is found at Säsebühl and Ochsenburg near Dransfeld, Steinberg near Münden, Habichtswald near Cassel, Striegau in Silesia, the Kausaw mountains in Bohemia, the Scheibenberg in Saxony, Cap de Prudelles in Auvergne, Wildenstein near Büdingen, Ettingshausen in the Vogelsgebirge, the Hebrides.

BOWENITE.—(Dana.) In granular masses. Fracture splintery. Translucent. Lustre vitreous. Bright apple-green. Tough. H = 6. G = 2·594...2·787. Analysis by Bowen:—silica 44·69, magnesia 34·63, lime 4·25, protoxide of iron 1·75, alumina 0·56, water 13·42. Is found at Smithfield in Rhode Island in nodules imbedded in granular limestone.

CAPORCIANITE.—In curved fibres. Greyish-red. Analysis by Anderson:—silica 52·8, alumina 21·7, red oxide of iron 0·1, lime 11·3, magnesia 0·4, potash 1·1, soda 0·2, water 13·1.

CHALILITE.—H = 4·5. G = 2·252. Analysis by Thomson:—silica 36·56, alumina 26·20, lime 10·28, red oxide of iron 9·28, soda 2·72, water 16·66. Is found at Sandy Brae in Antrim.

CLUTALITE appears to be pseudomorphous after some crystal belonging to the oblique system. Fibrous. Opaque... translucent on the edges. Lustre vitreous. Flesh-red. Brittle. H = 3·5. G = 2·166. Analysis by Thomson:—silica 51·27, alumina 23·56, red oxide of iron 7·31, soda 5·13, magnesia 1·23, water 10·55. Is found in amygdaloid near Dumbarton in Scotland.

COLLYRITE. — Fracture earthy, even, flat conchoidal. Dull. Streak shining. Opaque. White, reddish, greenish. H = 1·0...2·0. G = 2·06...2·11. Unctuous to the touch. Infusible before the blowpipe. Analysis of collyrite from Weissenfels by Kersten:—silica 23·3, alumina 42·8, water 34·7. Is found in reniform masses at Weissenfels, Schemnitz, Laubach, and in the Pyrenees.

DERMATINE.—Amorphous. Fracture conchoidal. Translucent on the edges. Lustre resinous, feeble. Dark green, brown. Streak yellowish-white, shining. Brittle. H = 2·5. G = 2·136. Unctuous to the touch. Analysis by Ficinus:—silica 35·80, magnesia 23·70, protoxide of iron 11·33, oxide of manganese 2·25, alumina 0·42, soda 0·50, water and carbonic acid 25·20. Is found in stalactitic and reniform masses with serpentine and calcite at Waldheim in Saxony.

DESMINE.—Nose. Jour des Mines, t. 25, p. 318. Small silky tufts accompanying Spinellane in the lavas of the extinct volcanoes of the Rhine.

CHLORASTROLITE.—Lustre pearly. Light blueish-green. H = 5·5...6. G = 3·180. Fusible before the blowpipe. Soluble in hydrochloric acid. Analysis by Whitney:—silica 36·99, alumina 25·49, red oxide of iron with a little protoxide 6·48, lime 19·90, soda 3·70, potash 0·40, water 7·22. Is found in rounded pebbles, consisting of diverging fibres, on the shores of Isle Royale in Lake Superior.

CHLOROPHÆITE.—(Macculloch.) Very soft, and dull green when first broken from the rock, but hardens afterwards and becomes black. G = 2·02. Infusible. Is decomposed by hydrochloric acid. Contains silica, iron and a little alumina. Is found imbedded in the amygdaloidal rock of the cliff of Scuirmore in the island of Rum, and in Fife. The chlorophæite of Forchammer is probably a different substance.

CHONIKRITE.—Fracture uneven, and imperfect conchoidal. Translucent...translucent on the edges. Dull or slightly glimmering. White, yellowish-white, greyish-white. Sectile. H = 3·0. G = 2·91. Before the blowpipe melts easily with ebullition into a greyish glass. With borax fuses slowly into a globule coloured by iron. Is completely decomposed by concentrated hydrochloric acid. Analysis by v. Kobell:—silica 35·69, alumina 17·12, magnesia 22·50, lime 12·60, protoxide of iron 1·46, water 9·00. Is found with pyrosklerite near Porto Ferrajo in Elba.

CIMOLITE.—Earthy, slaty. White, grey. G = 2·277. Analysis by Khretschatitzki:—silica 63·53, alumina 23·70, water 12·42. Is found in Russia and in the island of Argentiera.

DIPHANITE.—In hexagonal prisms having a very perfect cleavage perpendicular to the axis of the prism. Transparent...translucent. Lustre vitreous. Blueish when viewed in a direction parallel to the cleavage, white in a direction perpendicular to the cleavage. H = 5. G = 3·05. Analysis by v. Jewreinoff:—silica 34·02, alumina 43·33, lime 13·11, protoxide of iron 3·02, protoxide of manganese 1·05, water 5·34. Is found with phenakite and chrysoberyl in the emerald mines of the Ural.

EMERYLITE.—(Smith. Silliman's Journ. 1849. 7. 285.) Cleavage in one direction very perfect. White...grey, with a tinge of lilac. Brittle and inelastic. H = 3·5. G = 2·995. In the matrass yields water and traces of fluorine. Before the blowpipe exfoliates, emits a strong light and fuses on the edges of thin laminæ. Dissolves in borax forming a clear glass. Leaves a skeleton of silica in salt of phosphorus. Is not acted upon by acids. Analysis of emerylite from Aston by Crawe:—silica 32·31, alumina 49·24, lime 10·66, magnesia 0·30, potash and soda 2·22, water 5·27. Is found in brilliant micaceous scales associated with the emery from Asia Minor, and with corundum at Aston, Chester County, Pennsylvania.

EUPHYLLITE.—(B. Silliman. Silliman's Jour. 1849. 8. 381.) In six-sided prisms having a perfect cleavage parallel to the base. Lustre pearly. White...pale green. Laminæ brittle, inelastic. H = 3·0. G = 2·963. Chemical characters nearly the same as those of emerylite. Analysis by I. J. Crooke:—silica 39·04, alumina 51·38, lime 3·19, magnesia 1·09, soda 0·87, water 4·59.

FULLER'S EARTH.—Fracture uneven, earthy. Opaque. Dull. Green, inclining to white, yellow, brown. Streak shining. Sectile. G = 1·7...2·4. In water falls into powder. Analysis of fuller's earth from Reigate by Klaproth:—silica 53·00, alumina 10·00, oxide of iron 9·75, magnesia 1·25, lime 0·50, chloride of sodium 0·10, water 24·00. Is found massive at Nutfield near Reigate in Surrey, near Maidstone, Woburn, near Aix la Chapelle, in Saxony, Bohemia, Moravia, Silesia, Stiria.

GLOTTALITE.—Cubic. Translucent. Lustre vitreous. White. Brittle. H = 3·5. G = 2·181. Analysis by Thomson:—silica 37·01, alumina 16·31, red oxide of iron 0·50, lime 23·93, water 21·25. Is supposed to have been found at Port Glasgow in Scotland.

GREEN EARTH.—In small masses in the cavities of amygdaloidal rocks; pseudomorphous after augite. Fracture earthy. Glimmering...dull. Green of various shades. Streak the same, shining. Opaque. Slightly sectile. Soft...friable. G = 2·79...2·83. Analysis of green earth from Pozza in the shape of augite by Rammelsberg:—silica 45·87, alumina 11·18, protoxide of iron 24·63, magnesia 0·28, lime 1·50, potash 6·72, water 9·82. Is found at Monte Baldo near Verona, Oberstein Bohemia, the Faröe islands, Fassathal in the Tyrol in the shape of augite.

GRENGESITE.—In hemispherical masses having a radiated structure. Dark green. Streak greyish-green. H = 2·0. G = 3·1. Analysis by Hisinger:—silica 27·01, alumina 14·31, oxide of manganese 2·18, protoxide of iron 25·63, magnesia 14·31, water 12·53. Is found in the Grengesberg in Dalecarlia.

GYMNITE.—Translucent on the edges. Lustre resinous. Yellow. Not so hard as felspar. G = 2·216. Analysis by Thomson:—silica 40·16, magnesia 36·00, alumina 1·16, lime 0·80, water 21·60. Is found on the Bare Hills near Baltimore.

HALLOYSITE.—Fracture conchoidal...earthy. Translucent on the edges...opaque. Lustre waxy...earthy. White, blue, green, yellow. H = 1·5...2·5. G = 1·92...2·12. Infusible before the blowpipe. Gelatinizes with sulphuric acid. Analyses of halloysite *a* from Angleure, *b* from Housscha near Bayonne, both by Berthier, *c* from Guatequé in New Grenada by Boussingault, *d* from Le Youth, *e* from Thivieres, both by Dufrénoy, *f* from Miechowitz in Upper Silesia by Oswald:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	44·94	46·7	46·0	40·66	43·10	40·25
Alumina	39·06	36·9	40·2	33·66	32·45	35·00
Magnesia	—	—	—	—	1·70	0·25
Water	16·00	16·0	14·8	24·83	22·30	24·25

Is found in reniform masses at Angleure near Liege, Miechowitz near Tarnowitz in Silesia, France, New Grenada.

HISINGERITE.—Fracture conchoidal...uneven, earthy. Opaque. Lustre resinous, inclining to adamantine. Black. Streak yellowish-brown. Brittle. H = 3·0. G = 2·79...3·05. In the matrass yields water. Before the blowpipe melts into a grey, magnetic bead. Imparts the colour of iron to borax. Partially soluble in hydrochloric acid, leaving a residue of silica. Analyses of hisingerite *a* from Riddarhytta, *b* from Bodenmais, both by Hisinger, *c* from Bodenmais (thraulite) by v. Kobell, *d* from Riddarhytta, *e* from Gillinge, both by Rammelsberg, *f* from Orijerfvi, G = 2·791, by Hermann:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	36·30	31·78	31·28	33·07	32·18	29·51
Red ox. iron . . .	44·39	49·87	49·12	34·78	30·10	10·74
Protox. iron . . .				17·59	8·63	37·49
Lime	—	—	—	2·56	5·50	—
Magnesia	—	—	—	0·46	4·22	7·78
Water	20·70	20·00	19·12	11·54	19·39	13·00

Is found in reniform masses at Bodenmais in Bavaria, Riddarhytta, Orijerfvi, and in the iron mine of Gillinge in Sweden.

HURONITE.—In globular masses. Imperfectly cleavable, granular. Translucent on the edges. Lustre waxy, on the cleavages pearly. Light yellowish-green. Streak greyish-white. H = 3·25. G = 2·8625. Analysis by Thomson:—silica 45·80, alumina 33·92, protoxide of iron 4·32, lime 8·04, magnesia 1·72, water 4·16. Is found in blocks near Lake Huron in North America.

HYDROPHITE.—Fracture uneven, fibrous. Green. H = 3·5. G = 2·65. Infusible before the blowpipe. Analysis by Svanberg:—silica 36·19, protoxide of iron 22·73, magnesia 21·08, alumina 2·89, vanadic acid 0·11, water 16·08. Is found massive at Taberg in Sweden.

KIRWANITE.—Fibrous. Opaque. Dark olive-green. H = 2. G = 2·941. Analysis by Thomson:—silica 40·50, alumina 11·41, protoxide of iron 23·91, lime 19·78, water 4·35. Is found in cavities in a basaltic rock on the north-east coast of Ireland.

KEROLITE.—Fracture flat conchoidal. Translucent... translucent on the edges. Lustre resinous, feeble...dull. White passing into grey, yellow, green. Streak white, shining. Brittle. Unctuous to the touch. Does not adhere to the tongue. H = 2·0...3·0. G = 2·33...2·41. Analyses of kerolite *a* from Zöblitz by Melling, *b* by Delesse, *c* from Silesia by Kühn:—

	a	*b*	*c*
Silica	47·13	53·5	46·96
Alumina	2·57	0·9	—
Magnesia	36·13	—	31·26
Lime	—	28·6	—
Protoxide of iron . .	2·92	—	—
Water	11·50	16·4	21·22

Is found in reniform masses in serpentine at Kosemütz and Frankenstein in Silesia, Zöblitz and Hartmaunsdorf in Saxony.

LEDERERITE and ACADIOLITE are supposed to be chabasie. Ledererite is found at Cape Blomidon in Nova Scotia, in bright, transparent, six-sided prisms, having the terminal edges truncated. Acadiolite is yellow, in other respects resembles chabasie. Analyses *a* of ledererite by Hayes, *b* of acadiolite by Thomson:—

	a	*b*
Silica	49·47	52·4
Alumina	21·48	12·4
Red oxide of iron	0·14	2·4
Lime	11·48	11·6
Soda	3·94	—
Water	8·58	21·6
Phosphoric acid	3·48	—

LIEBNERITE.—In six-sided prisms. Lustre fatty. Greenish-grey. H = 3·5. G = 2·814. Intumesces but does not fuse before the blowpipe. Analysis by Marignac:—silica 44·66, alumina 36·51, protoxide of iron 1·75, magnesia 1·40, potash 9·90, soda 0·92, water and carbonic acid 4·49. Is found in porphyry in the Fassathal.

LINDSEYITE.— G = 2·796...2·83. In the matrass yields water. Melts with difficulty on the edges before the blowpipe. Is not completely decomposed by strong acids. Analyses by Komonen and Hermann:—

Silica	47·50	42·22
Alumina	35·29	27·55
Red oxide of iron	—	6·98
Protoxide of iron	7·03	2·00
Magnesia	3·56	8·85
Potash	—	3·00
Soda	—	2·53
Water	6·65	7·00

Is supposed to be pseudomorphous after anorthite or lepolite. Is found in the copper mine of Orijerfvi in Finland.

LITHOMARGE.— Fracture conchoidal. Opaque. Dull. Blue passing into red and grey. Streak shining. Sectile. Adheres to the tongue. H = 2·5. G = 2·496. Infusible before the blowpipe. Imparts the colour of iron to glass of borax. Analysis by Schüler:—silica 41·66, alumina 22·85, red oxide of iron 12·98, lime 3·04, magnesia 2·55, oxide of manganese 1·68, potash 0·93, water 14·20. Is found in beds at Planitz near Zwickau in Saxony.

MALTHACITE.—Massive. Fracture uneven...conchoidal. Lustre resinous, feeble. White, inclining to yellow. Translucent. Sectile. G = 1·95...2·0. Unctuous to the touch. Analysis by Meissner: — silica 50·2, alumina 10·7, lime 0·2, oxide of iron 3·1, water 35·8. Is found at Steindörfel in Upper Lusatia amongst blocks of decomposed basalt; and in clefts in greenstone near Litten in Bohemia.

MESOLE, BREVICITE, HARRINGTONITE, ANTRIMOLITE, LEHUNTITE are probably varieties either of scolezite or mesotype. Mesole.—Fibrous. Translucent. Pearly. White, yellowish, greyish. H = 3·5. G = 2·35...2·4. Silica 42·60, alumina 28·00, lime 11·43, soda 5·63, water 12·70. Berzelius. Before the blowpipe melts easily and quietly into a whitish glass. Is found in the Faröe islands, Annaklef in Schonen, Bombay. Brevicite.—In prisms and white cleavable masses. Silica 43·88, alumina 28·39, soda 10·32, lime 6·88, magnesia 0·21, water 9·63. Sondén. Is found near Brevig in Norway. Harringtonite.—Massive, earthy. Opaque. White. H = 5·25. G = 2·217. Silica 44·84, alumina 28·48, lime 10·68, soda 5·56, water with a trace of hydrochloric acid 10·28. Thomson. Is found in the north of Ireland. Antrimolite.—Fibrous. Opaque. White. H = 3·75. G = 2·096. Silica 43·47, alumina 30·26, lime 7·50, potash 4·10, protoxide of iron 0·19, chlorine 0·10, water 15·32. Thomson. In cavities of amygdaloid on the north coast of Antrim. Lehuntite.—Scaly. Translucent on the edges. Flesh-red. H = 3·75. G = 1·953. Silica 47·33, alumina 24·00, soda 13·20, lime 1·52, water 13·60. R. D. Thomson. Is found in amygdaloid near Glenarm in Ireland. Analyses *a* of hypostilbite from the Faröe islands, globular, fibrous or compact, white, G = 2·14, does not scratch glass, intumesces slightly before the blowpipe, and melts with difficulty, soluble in acids without gelatinizing, by Beudant; *b* of sphærostilbite from the Faröe islands, globular, fibrous, lustre pearly, harder than calcite, G = 2·31, melts with intumescence, soluble in acids, forming a jelly, by Beudant; *c* of the red zeolite from Ædelforss, by Retzius; *d* of prehnite-like stilbite from the Faröe islands, by Retzius, *e* of a red zeolite from Mora Stenar by Sjögren, who supposes this mineral, red zeolite, mehlzeolith, ædelforsite, to be laumontite more or less impure :—

	a	*b*	*c*	*d*	*e*
Silica	52·43	55·91	60·28	56·76	51·61
Alumina	18·32	16·61	15·42	17·73	19·06
Red ox. iron . .	—	—	4·16	—	2·96
Lime	8·10	9·03	8·18	4·50	12·53
Soda	2·41	0·68	Ṁg, Ṁn 0·42	2·53	—
Water	18·70	17·84	11·07	18·33	14·02

MONRADITE.—Cleavage in two directions, making with each other an angle of 50°, one distinct, the other indistinct. Translucent. Lustre, on the planes of distinct cleavage vitreous; on the fracture dull. Honey-yellow. Streak white. H = 6·0...6·5. G = 3·2673. Analysis by A. Erdmann :—silica 56·17, magnesia 31·53, protoxide of iron 8·56, water 4·04. Is found in the parish of Bergen in Norway.

MONROLITE.—(B. Silliman. Silliman's Journ. 1849. 8. 385.) In cleavage and form resembles sillimanite. Green... greenish-grey. H = 7·25 on an angle, 6 on cleavage face. G = 3·045...3·096. In the matrass yields water. Infusible before the blowpipe. Analyses by B. Silliman :—

Silica	40·92	40·39	40·39

Alumina	56·61	55·73	56·62
Magnesia	0·28	0·28	0·28
Water	3·09	1·84	2·79

Is found at Monroe, Orange County, New York.

MOSANDRITE.—Cleavage in one direction distinct, traces in several other directions. In thin fragments translucent. Lustre resinous, on the plane of distinct cleavage, inclining to vitreous. Dark reddish-brown; by transmitted light bright red. Streak greyish-brown. H = 4. G = 2·93. In the matrass yields much water. Becomes brownish-yellow by ignition. Before the blowpipe melts easily with ebullition into a brownish-green, dull bead. Easily soluble in borax, forming a violet bead which becomes yellow, or nearly colourless, in the inner flame. With soda yields the reaction of manganese. Is completely decomposed by hydrochloric acid. Contains silica, titanic acid, oxides of cerium, lanthanium, manganese, lime, magnesia, potash, water. In tabular and prismatic crystals, and massive. Is found in syenite on Lamansskäret, a small island not far from Brevig in Norway.

MOUNTAIN SOAP. — Massive. Fracture conchoidal, earthy. Opaque. Black, dull. Streak shining. H = 1·0...2·0. Analysis by Bucholz:—silica 44·0, alumina 26·5, red oxide of iron 8·0, lime 0·5, water 20·5. Is found at Olkucz in Poland, Bilin in Bohemia, the island of Skye.

MOUNTAIN WOOD.—Opaque. Lustre silky, inclining to waxy. Wood-brown. Streak the same, shining. In thin splinters elastic. Adheres to the tongue. H = 2·5. G = 1·5. Analysis of mountain wood from Sterzing by Thaulow:—silica 55·51, alumina 0·04, red oxide of iron 19·56, magnesia 14·41, lime 0·12, water 10·36. Is found in fibrous masses closely resembling rotten wood, at Sterzing in the Tyrol, and in a bed of iron ore on the Büchenberg near Elbingerode in the Harz.

NEUROLITE.—Fibrous. Fracture uneven. Opaque... translucent on the edges. Greenish-yellow. H = 4·25. G = 2·476. Analysis by Thomson:—silica 73·00, alumina 17·35, lime 3·25, magnesia 1·50, protoxide of iron 0·40, water 4·30. Is found at Stamstead in Lower Canada.

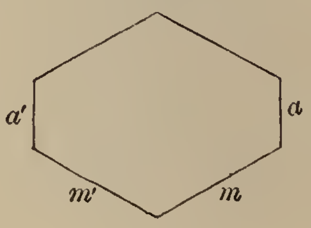
NONTRONITE.—Fracture uneven. Opaque. Dull. Lustre of the streak resinous. Straw-yellow, yellowish-white, greenish.

Unctuous to the touch. Very soft. G = 2·08. Before the blowpipe becomes red. Is decomposed by hot hydrochloric acid, forming a jelly of silica. Analysis by Dufrénoy:—silica 40·68, alumina 3·96, red oxide of iron 30·19, magnesia 2·37, water 23·00. Is found in small reniform masses in a bed of manganese ore near Saint-Pardoux, Villefranche, and Montmort in France.

OCHRAN.—Fracture conchoidal. Lustre vitreous, inclining to resinous. Yellow. Streak pale yellow. Slightly brittle. G = 2·483. Before the blowpipe imparts a green colour to the flame. Decomposed by hydrochloric acid, forming a jelly of silica. Analysis by Kersten:—silica 31·3, alumina 43·0, red oxide of iron 1·2, water 21·0, boracic acid a trace. Is found at Orawitza in the Banat.

OKENITE.—Prismatic. *a* 100, *m* 110. *ma* = 61° 10′, *mm′* = 57° 40′. Translucent. Lustre pearly. Yellowish-white, blueish-white H = 4·5…5·0. G = 2·28…2·36. In the matrass yields water. Before the blowpipe melts with intumescence into an enamel. With borax forms a colourless glass. Is easily decomposed by hydrochloric acid, forming a jelly of silica. $\dot{C}a\,\dddot{S}i^2\dot{H}^2$, silica 57·24, lime 26·03, water 16·73. Analyses of okenite *a* from Disco by v. Kobell, *b* from the Faröe islands by Connel, *c* from Iceland by Würth:—

FIG. 644.



	a	*b*	*c*
Silica	55·64	57·69	54·88
Lime	26·59	26·83	26·15
Alumina	0·53	—	0·46
Red oxide of iron		0·32	—
Oxide of mangan.	—	0·22	—
Potash	—	0·23	—
Soda	—	0·44	1·02
Water	17·00	14·71	17·94

Is found in acicular crystals and massive, in amygdaloidal rock in the island of Disco, at Tupaursak in Greenland, in the Faröe islands, in Iceland.

OSMELITE.—Analysis of osmelite from Niederkirchen by Riegel:—silica 58·33, alumina 13·85, lime 10·42, red oxide of iron 1·15, water 16·10.

PHOLERITE.—Scaly, fibrous. Translucent on the edges.

Lustre pearly. White, greyish, greenish. Friable. Adheres to the tongue. G = 2·35...2·57. $\dddot{\bar{A}}l^2\dddot{S}i^3 + 4\dot{H}$. Analyses by Guillemin:—

Silica	40·75	42·93	41·65
Alumina	43·89	42·07	43·35
Water	15·36	15·00	15·00

Is found at Freiberg, Ehrenfriedersdorf and Zwickau in Saxony, in the mines of Fins and Rives de Giers in the department of Allier in France.

PIKROPHYLL.—Dark green. H = 2·5. G = 2·73. Analysis by Svanberg:—silica 49·80, magnesia 30·10, protoxide of iron 6·86, lime 0·78, alumina 1·11, water 9·83. Is found at Sahla in Sweden.

PIMELITE.—Fracture flat conchoidal. Translucent...translucent on the edges. Lustre waxy. Apple-green. Streak greenish-white. H = 2·5. G = 1·458...2·289. Infusible. With soda in the inner flame yields nickel. Analysis by Schmidt:—silica 54·63, oxide of nickel 32·66, magnesia 5·89, lime 0·16, protoxide of iron 1·13, alumina 0·30, water 5·23. Is found massive and investing other minerals at Thomnitz, Kosemütz and Gläsendorf near Frankenstein in Silesia.

PINGUITE.—Massive. Fracture conchoidal, uneven, splintery. Lustre resinous, feeble. Siskin-green, oil-green. Streak the same, paler, shining. Sectile. Unctuous. H = 1·0. G = 2·315. In the matrass yields water. With borax forms a glass coloured by iron. Is decomposed by hydrochloric acid, leaving silica in powder. Analysis by Kersten:—silica 36·90, alumina 1·80, red oxide of iron 29·50, protoxide of iron 6·10, oxide of manganese 0·15, magnesia 0·45, water 25·10. Is found in veins of barytes in gneiss at Wolkenstein in Saxony, in a bed of red oxide of iron at Rothehütte not far from Elbingerode in the Harz, in basalt at the Pflasterkaute, near Suhl in Thuringia.

PINITE, GIESECKITE, OOSITE, KILLINITE, FAHLUNITE, BONSDORFFITE, ESMARKITE, ASPASIOLITE, PYRARGILLITE, CHLOROPHYLLITE, GIGANTOLITE, PRASEOLITE, IBERITE, WEISSITE.—These substances are supposed to be cordierite more or less changed. Pinite shows the faces *a*, *b*, *c*, *m*, *r*, *s* of cordierite. Faces of union parallel to *c*. Fracture uneven...splintery. Faintly translucent on the edges...opaque. Lustre vitreous, feeble. Grey, brown, green. Streak white. Sectile. H = 2·0...2·5. G = 2·78...2·83. Fusible before the blowpipe. Occurs imbedded in granite, porphyry, gneiss and mica slate. Is found in several places in Auvergne, near Elbingerode and Stolberg in the Harz, at Schneeberg and Penig in Saxony, near Rastadt in Baden, Iglau in Moravia, Arendal in Norway, Haddam in Connecticut, St. Michael's Mount in Cornwall, in Aberdeenshire. The variety called gieseckite is found at Akulliarasiarsuk in Greenland. Oosite, from the valley of Oos in Baden, resembles pinite. Killinite.—Fracture uneven. Faintly translucent. Lustre vitreous, inclining to pearly. Greenish-grey, passing into yellow. Streak yellowish-white. Sectile. H = 4·0. G = 2·65. Fusible before the blowpipe. Is found in granite veins at Killiney near Dublin.

Analyses of pinite *a* from Penig, *b* from Aue near Schneeberg, *c* from St. Pardoux, all by Rammelsberg, *d* from St. Pardoux, *e* from Saxony, *f* from Mont Breven, all by Marignac:—

	a	*b*	*c*	*d*	*e*	*f*
Silica	47·00	46·83	48·92	47·50	46·10	44·70
Alumina	28·36	27·65	32·29	31·80	32·46	31·64
Red ox. iron . . .	—	—	3·49	3·92	4·27	6·57
Protox. iron . . .	7·08	7·84	—	—	—	—
Lime	0·79	0·49	0·51	0·92	—	—
Protox. mangan. . .	—	—	0·11	—	—	—
Magnesia	2·48	1·02	1·30	—	2·26	2·86
Potash	10·74	6·52	9·14	9·05	9·00	7·89
Soda	1·07	0·40	—	1·78	0·46	0·95
Water	3·83	7·80	4·27	5·03	5·45	5·39

Analyses of pinite *g* from Auvergne by C. Gmelin, *h* from Neustadt in Saxony by Ficinus, *i* from Penig by Scott, *k* from Greenland (gieseckite) by Pfaff, of killinite *l* by Lehunt, *m* by Blyth:—

	g	*h*	*i*	*k*	*l*	*m*
Silica	55·96	54·6	48·00	48·0	49·08	47·93
Alumina	25·48	23·6	28·00	32·5	30·60	31·04
Red ox. iron . . .	5·51	—	—	4·0	—	—
Protox. iron . . .	—	7·8	9·66	—	2·27	2·33
Ox. mangan.	3·76	1·6	—	—	—	1·25
Magnesia		0·8	—	1·5	1·08	0·46
Potash	7·89	11·2	11·35	6·5	6·72	6·06
Soda	0·39	Ca	0·75	—	0·68	0·72
Water	1·41	1·2	3·00	5·5	10·00	10·00

Fahlunite.—Fracture splintery, uneven, conchoidal. Opaque ...translucent on the edges. Lustre vitreous, waxy. Green, black, brown. Streak white. H = 2·5...3·0. G = 2·62...3·79. Melts on the edges before the blowpipe. Is found in imbedded crystals having rounded edges, and massive, at Fahlun in Sweden in chlorite slate. Bonsdorffite.—Cleavage parallel to the faces *c* of cordierite. Fracture conchoidal. In thin leaves translucent. Lustre waxy. Greenish-brown... olive-green. H = 3·5. Infusible before the blowpipe. Is found in six-sided prisms with cordierite in granite near Abo in Finland. Esmarkite.—Cleavage parallel to the faces *c* of cordierite. Fracture uneven, splintery. Translucent on the edges. Lustre pearly on the cleavage, on the surfaces of fracture vitreous, inclining to resinous. Green. H = 3·5. G = 2·709. Fusible with difficulty on the edges before the blowpipe. In imbedded crystals having rounded edges, an uneven surface and imperfect terminations. Is found with chlorite imbedded in quartz near Brevig in Norway. Aspasiolite occurs in crystals having the form of cordierite. Green of various shades, sometimes inclining to brown. H = 3·0. G = 2·764. Infusible before the blowpipe. Is decomposed by boiling hydrochloric acid. Is found in gneiss in the neighbourhood of Kragerö in Norway containing portions of colourless or pale violet cordierite. Pyrargillite.—Fracture uneven. Translucent on the edges...opaque. Lustre resinous, feeble. Greyish-blue, brown, red. H = 3·5. G = 2·5. Infusible before the blowpipe. Is completely decomposed by hydrochloric acid. Is found in indistinct imbedded crystals, and massive, in granite at Helsingfors in Finland. Analyses of fahlunite *n*, *o* by Trolle Wachtmeister, *p* of bonsdorffite by v. Bonsdorff, *q* of esmarkite by Erdmann, *r* of aspasiolite by Scheerer, *s* of pyrargillite by Nordenskiöld:—

	n	*o*	*p*	*q*	*r*	*s*
Silica	44·60	44·95	45·05	45·97	50·90	43·93
Alumina	36·10	30·70	30·05	32·08	32·38	28·93
Protox. iron . . .	3·86	7·22	5·30	3·83	2·34	5·30
Protox. mangan. . .	2·24	1·90	—	0·41	—	—
Lime	1·35	0·95	—	—	Ṅa	1·85
Magnesia	6·75	6·04	9·00	10·32	8·01	2·90
Potash	1·98	1·38	—	—	—	1·05
Water	9·35	8·65	10·60	5·49	6·73	15·47

Chlorophyllite occurs in six-sided prisms, with a cleavage perpendicular to the axis of the prism. Green...brownish. Brittle. H = 1·5...2·0 on the ends, H = 5 on the edges. G = 2·7. Is found at Haddam. Gigantolite occurs in twelve-sided prisms having either a cleavage or faces of union separated by films of chlorite perpendicular to the axis of the prism. Lustre on the faces perpendicular to the axis of the prism imperfect metallic. Greenish-grey. Streak white. H = 3·5.

G = 2·86…2·88. Melts into a green slag before the blowpipe. Is found in large crystals in granite in the neighbourhood of Tammela in Finland. Praseolite occurs in imbedded four, six, eight and twelve-sided prisms, having their edges and angles rounded, and cleavable in a direction perpendicular to the axis of the prism. Fracture splintery…flat conchoidal. Translucent on the edges. Green of various shades. Streak greenish-white. Sectile. H = 3·5. G = 2·754. Before the blowpipe fuses with difficulty on the edges into a blueish-green glass. Is found in a vein of quartz in gneiss at Bräkke near Brevig in Norway. The interior of a crystal in the Museum at Vienna consists of unaltered cordierite. Iberite occurs in large six-sided prisms cleavable parallel to the lateral and terminal faces of the prism. Fracture splintery. Opaque. Lustre vitreous, inclining to pearly. Light green…grey. H = 2·5. G = 2·5. Fusible with difficulty before the blowpipe into a dark glass. Is found at Montalvan in the province of Toledo. Weissite resembles fahlunite. Grey…brown. G = 2·8. Is found at Fahlun. Analyses *t* of chlorophyllite by Rammelsberg, *u* of gigantolite by Trolle Wachtmeister, *v* of gigantolite by Komonen, *w* of praseolite by Erdmann, *x* of iberite by Norlin, *y* of weissite by Trolle Wachtmeister :—

	t	*u*	*v*	*w*	*x*	*y*
Silica	46·31	46·27	45·6	40·94	40·90	53·69
Alumina	25·17	25·10	26·7	28·79	30·74	21·70
Red ox. iron . . .	10·99	15·60	—	7·73	—	Żn 0·30
Protox. iron . . .	—	—	12·4	—	15·47	1·43
Protox. mangan. . .	—	0·89	0·9	0·32	1·33	0·63
Lime	0·58	—	(T̈i, &c.	0·50)	0·40	—
Magnesia	10·91	3·80	2·4	13·43	0·81	8·99
Patash	—	2·70	5·8	—	4·57	4·10
Soda	—	1·20	—	—	0·04	0·68
Water	6·70	6·00	6·2	7·38	5·57	3·20

PIPESTONE.—Fracture earthy. Opaque. Dull. Light greyish-blue. H = 1·5. G = 2·606. Sectile. Analysis by Thomson:—silica 56·11, alumina 17·31, red oxide of iron 6·96, magnesia 0·20, lime 2·17, soda 12·48, water 4·58. Is found between Nootka Sound and the Columbia River.

PYRALLOLITE.—*lm* = 39° 11′, *rm* = 35° 57′, *rt* = 49° 27′, *mt* = 85° 24′. *l*, *m*, *r* are in the same zone. Fracture uneven, earthy. Translucent on the edges…opaque. Lustre vitreous, on the cleavage faces pearly. White, inclining to green, light greenish and yellowish-grey. Slightly brittle. H = 3·5…4·0. G = 2·55…2·60. In the matrass yields water. Before the blowpipe blackens, then grows white, intumesces, and in a strong heat melts on the edges. With soda fuses into a transparent globule. Analysis by Nordenskiöld :—silica 56·62, magnesia 23·38, lime 5·58, protoxide of manganese 0·99, red oxide of iron 0·09, alumina 3·38, water 3·58, bituminous matter and loss 6·38. Is found in crystals, columnar or granular masses, at Storgard in the parish of Pargas in Finland, with augite, felspar, scapolite, apatite and sphene, in a bed of granular limestone. According to G. Bischof, pyrallolite is decomposed augite.

PYROSKLERITE.—Prismatic. Cleavage in two directions, making right angles with each other, one perfect, the other imperfect. Fracture uneven and splintery. Translucent. Lustre pearly on the surface of perfect cleavage, feeble. The surface of fracture dull. Apple-green…emerald-green, greyish-green. Streak white. Sectile. H = 3·0. G = 2·74. In the matrass yields water. Before the blowpipe melts with difficulty into a greyish glass. With borax fuses into a chrome-green globule. In powder is completely decomposed by concentrated hydrochloric acid, leaving the silica in powder. Analysis by v. Kobell:—silica 37·03, alumina 13·50, oxide of chrome 1·43, magnesia 31·62, protoxide of iron 3·52, water 11·00. Is found in crystalline masses with chonikrite, with which it is sometimes intimately mingled, in veins in serpentine, near Porto Ferrajo in Elba.

RAZOUMOFFSKIN.—Analysis by Zellner:—silica 54·50, alumina 27·25, lime 2·00, magnesia 0·37, protoxide of iron 0·25, water 14·25. Is found at Kosemütz in Silesia.

ROSELLANE.—Cleavage in one direction perfect. Fracture splintery. Translucent…Semi-transparent. Lustre on cleavage planes vitreous, inclining to resinous; on surfaces of fracture dull. Rose-red, inclining to violet and brownish-red. Streak white. H = 2·5…4·0. G = 2·72. In the matrass yields water and loses its colour. Before the blowpipe melts with difficulty into a white slag. With soda fuses readily. Analyses *a* of rosellane, H = 2·5, from Aker, *b* from Tunaberg, H = 4 (polyargit), both by Svanberg:—

	a	*b*
Silica	44·90	44·13
Alumina	34·51	35·12
Red ox. iron	0·69	0·96
Oxide of mangan. . .	0·19	trace
Lime	3·59	5·55

	a	*b*
Magnesia	2·45	1·43
Potash	6·63	6·73
Water	6·53	5·29

Rosellane is found in small grains imbedded in limestone at Aken and at Baldurstadt in Södermanland in Sweden. Polyargit is found at Kärrgrufva in the parish of Tunaberg in Sweden.

SAMOINE.—(Dana.) In stalactites having a lamellar concentric structure. White, greyish or brownish. H = 4·0...4·5. G = 1·689...1·894. Gelatinizes in nitric or hydrochloric acid. Analysis by Silliman, jun.:—silica 35·14, alumina 31·95, magnesia 1·05, carbonate of lime 1·21, water 31·95. Is found covering the roof of a lava cavern in the island of Upolu.

SISMONDINE.—Easily cleavable in one direction. Bright. Dark green. Streak light greyish-green. G = 3·565. Analysis by Delesse:—silica 24·1, alumina 43·2, protoxide of iron 23·8, water 7·6. Is found at St. Marcel in Piedmont.

SMECTITE.—An amorphous mineral from Cilly in Stiria. Analysis by L. A. Jordan:—silica 51·21, alumina 12·25, red oxide of iron 2·07, magnesia 4·89, lime 2·13, water 27·89.

SORDAWALITE.—Fracture conchoidal. Opaque. Lustre resinous or vitreous. Brownish-black...blackish-green. Streak liver-brown. Brittle. H = 4·0...4·5. G = 2·55...2·62. Melts before the blowpipe into a black globule. Is imperfectly decomposed by acids. Analysis by Nordenskiöld:—silica 49·40, alumina 13·80, protoxide of iron 18·17, magnesia 10·67, phosphoric acid 2·68, water 4·38. Is found at Sordawala in Finland.

SPADAITE.—Fracture imperfect conchoidal, splintery. Translucent. Lustre resinous, feeble. Light red. Streak white. Sectile. H = 2·5. In the matrass yields water and turns grey. Before the blowpipe melts into an enamel. Is decomposed by concentrated hydrochloric acid. $3\dot{M}g\bar{S}i + 2\dot{M}g\dot{H}^2$, silica 57, magnesia 32, water 11. Analysis by v. Kobell:—silica 56·00, magnesia 30·67, protoxide of iron 0·66, alumina 0·66, water 11·34. Occurs massive, with wollastonite, at Capo di Bove near Rome.

THURINGITE.—Massive. Cleavage distinct in one direction. Lustre pearly. Olive-green. Streak siskin-green. H =

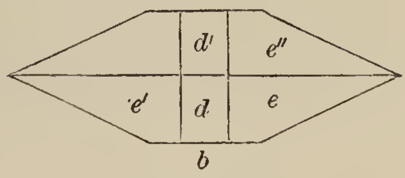
2·0...2·5. G = 3·151...3·157. Analysis by Rammelsberg:—silica 22·41, red oxide of iron 21·94, protoxide of iron 42·60, magnesia 1·16, water 11·89. Is found near Saalfeld.

TRIPOLI.—Fracture earthy. Opaque. Dull. Grey. Soft, friable. G = 1·86...2·2. Analysis by Bucholz:—silica 81·00, alumina 1·50, red oxide of iron 8·00, water 4·55, sulphuric acid 3·45. Is found near Prague, in Saxony, France, England, Tripoli, Corfu.

UNIONITE.—(B. Silliman. Silliman's Journal. 1849. 8. 384.) Cleavage in one direction distinct; in two other directions less distinct. Lustre vitreous. White...yellowish-white. Brittle. H = 6·0...6·5. G = 3·2984. In the matrass yields water and fluorine. Before the blowpipe intumesces and melts into a white enamel, emitting a brilliant light. Analysis by B. Silliman:—silica 44·15, alumina 42·26, magnesia 7·36, soda 1·73, water and fluorine 3·53.

VILLARSITE.—Prismatic. $db = 39^\circ\ 23'$, $dd' = 101^\circ\ 14'$, $eb = 43^\circ\ 28'$, $ee'' = 93^\circ\ 4'$, $ee' = 40^\circ\ 15'$, $e'e'' = 106^\circ\ 52'$. Fracture granular. Translucent. Yellowish-green. Soft. G = 2·978. Infusible before the blowpipe. With borax yields a green enamel. Is decomposed by strong acids. Analysis by Dufrénoy:—silica 39·40, magnesia 45·33, protoxide of iron 4·30, protoxide of manganese 2·86, lime 0·54, potash 0·46, water 5·80. Is found in a bed of magnetite at Traversella in Piedmont. It is supposed to be an altered olivine.

FIG. 645.



WARWICKITE. — Oblique. Cleavage in one direction very perfect. Fracture uneven. Lustre vitreous, on cleavage pearly. Hair-brown...iron-grey. Streak blueish-black. Brittle. H = 3·0...4·0. G = 3·188...3·29. In the matrass yields water. Infusible before the blowpipe. With salt of phosphorus yields a bead which is orange while hot, and purplish-grey and opaque when cold. Analysis by T. S. Hunt:—titanic acid 28·20, silica 18·50, alumina 13·84, protoxide of iron 10·59, magnesia 22·20, lime 1·30, water 7·35. Is found in crystals near Edenville in New York.

ZEAGONITE.—Analysis of a mineral from Vesuvius called zeagonite, distinguishable from Phillipsite by losing one-third of the water contained in it at 100° C, and becoming opaque, by Marignac:—silica 35·88, alumina 27·23, lime 13·12, potash 2·85, water 21·10.

XEUXITE.—In small, flat, right-angled prisms, and fibrous masses. Opaque. Lustre vitreous. Brown, inclining to green. H = 4·25. G = 3·051. Analysis by Thomson:—silica 33·48, alumina 31·85, protoxide of iron 26·01, lime 2·46, water 5·28. Was found near Redruth in Cornwall.

XYLITE.—Fibrous. Opaque. Glimmering. Brown... yellow. Fusible with difficulty on the edges before the blowpipe. Soluble in borax, imparting to it the colour of iron. Partially decomposed by acids. H = 3·0. G = 2·935. Analysis by Hermann:—silica 44·97, red oxide of iron 38·61, lime 6·71, magnesia 5·53, water 4·18. Is supposed to have been found in one of the copper mines in the Ural.

ALLUAUDITE.—Analysis by Vauquelin:—phosphoric acid 27·85, red oxide of iron 56·20, oxide of manganese 6·76, water 9·29. Is found in Haute Vienne.

ANTIMONPHYLLITE.—Oblique. *b* 010, *m* 110. Cleavage. *b*, very perfect. Semi-transparent. Lustre pearly, inclining to adamantine. Greyish-white. In thin leaves flexible. H = 1·0...1·5. G = 4·025. Its reactions before the blowpipe are the same as those of valentinite.

ARÆOXENE.—Is found in crystalline and columnar masses at Dahn in the Palatinate with galena. Deep red. Streak pale yellow. H = 3. On charcoal melts easily with intumescence before the blowpipe, and yields an arsenical odour and a globule of lead. With borax in the inner flame melts into a bright green glass, which becomes light olive-green and then yellow in the outer flame, and takes a pale green colour when cold. Is decomposed by concentrated hydrochloric acid. In 100 parts of the mineral v. Kobell found PbO 48·7, ZnO 16·32.

ARSENOCROCITE Arseniosiderite.—In globular aggregations composed of easily separable fibres. Lustre silky. Brownish-yellow. H = 1...2. G = 3·52...3·9. Analysis by Rammelsberg:—arsenic acid 39·16, red oxide of iron 40·00, lime 12·18, water 8·66. Is found at Romanèche near Mâcon.

AZORITE.—Pyramidal. *a* 100, *e* 101. $aa' = 90° 0'$, $ea = 46° 20'$, $ee' = 56° 45'$. No cleavage observable. Translucent...opaque. Lustre vitreous on the surface of fracture. Colourless, white inclining to greenish-yellow. H = 4·0...4·5. Infusible before the blowpipe. With borax, on platinum wire, dissolves with great difficulty into a transparent globule. Dissolves slowly in salt of phosphorus, forming a pale green bead. According to A. A. Hayes, consists of niobate of lime. Is found in the Azores, in an albitic rock, with black tourmaline and pyrrhite.

BEUDANTITE.—According to Levy rhombohedral. *rr′* = 87° 30′. It was supposed by Descloizeaux and Damour to agree with pharmacosiderite both in form and composition. We have examined crystals of this mineral taken from the particular specimen from Horhausen described by M. Levy, and Dr. Percy has analyzed a minute portion of the same specimen. The crystals which are opaque and black, if not rhombohedral, are remarkably deceptive, having only one of the triangular faces which occur on the alternate solid angles of the cubes, and that face, instead of being uneven and bright, as in the cubic arseniate, is very flat, but so dull as scarcely to reflect a ray of light, and is disproportionally large when compared with those on the cubic crystals. The other faces also of Levy's specimen are brighter than those of the cubes, but are so much curved and otherwise irregular as not to afford any measurements that can be relied upon. Some of these, however, approach nearly to those of pharmacosiderite as given by Phillips. Two analyses of a very small quantity of Levy's specimen gave the following results:—

Arsenic acid	9·68	13·60
Phosphoric acid	1·46	not det.
Sulphuric acid	12·31	12·35
Red oxide of iron	42·46	37·65
Oxide of lead	24·47	29·52
Water	8·49	8·49

From which it appears that if Levy's specimen is to be regarded as pharmacosiderite, it contains an unusually large proportion of foreign matter.

BLEINIERE.—This name has been given to the results of the decomposition of various sulphides of lead and antimony, some of which are sulphate of oxide of lead without any admixture of antimony; another from Nertschinsk, analyzed by Hermann, consisted of antimonic acid 31·71, oxide of lead 61·38, water 6·46.

BLÖDITE.—Analysis by John:—sulphate of magnesia 36·66, sulphate of soda 33·34, sulphate of protoxide of manganese 0·33, chloride of sodium 0·33, sulphate of protoxide of iron 0·34, water 22·00. Was found at Ischel.

CARPHOSIDERITE.—Botryoidal and reniform. Lustre fatty. Straw-yellow. H = 4·0...4·5. G = 2·49...2·51. According to Harkort, is a hydrous phosphate of iron oxide with some zinc oxide. Labrador.

CHLORIDE OF IRON.—Earthy. Dull. Brownish-red. Deliquesces when exposed to the air. Sublimes before the blowpipe. Easily soluble in water and in alcohol. Fe^2Cl^3, chlorine 65·02, iron 34·98. Is found as a sublimate investing other minerals on Vesuvius and in Iceland.

CHLORIDE OF VANADIUM.—The only notice we have of this mineral is in a letter from Del Rio, of April, 1837, in which he states that he had named it zimapanio, and that when he first saw it he supposed it to be a reddish-brown ferruginous clay, which it much resembles. Whether it is chloride of vanadium or not, the editors cannot say. It occurs as a thin earthy coating on crystals of vanadiate of lead, and is disseminated in small quantities through the matrix which accompanies the vanadiate.

DELVAUXINE. — Amorphous. Fracture conchoidal. Opaque...translucent on the edges. Lustre waxy...dull. Brownish-black...brownish-yellow. Streak light brownish-yellow. H = 2·5. G = 1·85. Analyses *a*, *b* by Dumont, *c* by Delvaux :—

	a	*b*	*c*
Phosphoric acid	16·04	16·57	18·20
Red oxide of iron	34·20	36·62	40·44
Water	49·76	46·81	41·13

Was found near Visé in Belgium.

DIADOCHITE.—Amorphous. Fracture conchoidal. Translucent...opaque. Lustre waxy...vitreous. Yellow...yellowish-brown. Streak white. H = 3·0. G = 2·035...2·037. Analysis by Plattner :—phosphoric acid 14·05, sulphuric acid 14·37, red oxide of iron 37·65, water 33·30. Is found in reniform masses in the alum-shale works at Arnsbach near Gräfenthal and at Garnsdorf near Saalfeld in the Thüringer Wald.

DRÉELITE. — Rhombohedral. *r* 100. *rr′* = 86°...87°. Cleavage. *r*. Lustre pearly, dull. White. H = 3·5. G =

3·2...3·4. Analysis by Dufrénoy:—sulphate of barytes 61·73, sulphate of lime 14·27, carbonate of lime 8·05, lime 1·52, silica 9·71, alumina 2·40, water 2·31. Was found at la Nussière near Beaujeu in France.

EMERALD NICKEL.—In stalactitic and compact masses. Transparent...translucent. Lustre vitreous. Emerald-green. Streak paler. H = 3...3·25. G = 2·57...2·693. Analysis by B. Silliman, jun.:—carbonic acid 11·69, oxide of nickel 58·81, water 29·49. Is found on chromite at Texas in Lancaster county, Pennsylvania.

FLUOCERINE.—Traces of cleavage in various directions. Fracture conchoidal. Opaque, translucent on the thinnest edges. Lustre resinous, inclining to vitreous. Yellow, red, brown. Streak brownish-yellow. H = 4·5. In the matrass yields water and becomes darker. Infusible before the blow-pipe. Is black while hot, in cooling becomes dark brown, then red, and lastly bright yellow. With salt of phosphorus melts into a glass which is red while hot, but becomes transparent and colourless on cooling. Soluble in hot sulphuric or hydrochloric acid. $Ce^2F^3 + 3Ce^2O + \dot{H}$. From 100 parts of fluocerine Berzelius obtained:—oxide of cerium 84·20, water 4·95. Is found very sparingly in crystalline masses imbedded in albite and red felspar in a granite vein at Finbo near Fahlun in Sweden.

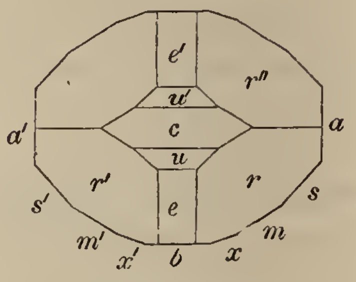
HAYESINE.—Hydroborocalcite. White. In warm water swells to eight times its original volume. $\dot{C}a\dddot{B}^2 + 6\dot{H}$. Analysis by Hayes:—boracic acid 46·11, lime 18·89, water 35·00. Occurs in fibrous masses very abundantly, with pickeringite and glauberite, on the dry plains near Iquique in Peru. A substance called tiza, in nodules, consisting in the interior of silky crystalline fibres, occurs with glauberite in the beds of nitre in the south of Peru. It is considered by Dana to be probably the same mineral as Hayesine. G = 1·8. Scarcely soluble in cold water; soluble with difficulty in boiling water. Readily soluble in acids. Analysis by Ulex:—boracic acid 49·5, lime 15·7, soda 8·8, water 26·0.

HERRERITE is a rhombohedral mineral, cleavable parallel to the faces *r* 100. Lustre vitreous. Green of various shades. H = 4·0...5·0. G = 4·3. It consists, according to Del Rio, of carbonate of oxide of zinc coloured by nickel. It is found with ores of lead and silver in veins in transition limestone at Albarradon in Mexico.

HOPEITE.—Prismatic. 011,010 = 50° 30′; 101,001 = 25° 15′; 110,100 = 60° 13′. *a* 100, *b* 010, *c* 001, *e* 011, *u* 013, *m* 110, *s* 210, *x* 230, *r* 111.

bc	90° 0′		*ss′*	97° 40′	
ca	90	0	*xx′*	41	44
ab	90	0	*ra*	70	0
ee′	79	0	*rr′*	40	0
uu′	30	44	*rr″*	73	24
mm′	59	34	*r′r″*	87	3

FIG. 646.



Combinations. *abmre*, *cersab*, *abmxsrceu*. The faces *a* striated parallel to their intersections with *s*. Cleavage. *b*, perfect; *a*, less perfect. Fracture uneven. Transparent...translucent. Lustre vitreous; on *b* pearly. Greyish-white. Streak white. H = 2·5...3·0. G = 2·85. In the matrass yields water. Before the blowpipe imparts a green colour to the flame, and melts easily into a transparent bead. With soda on charcoal deposits a copious sublimate of oxide of zinc, and some oxide of cadmium. Perfectly soluble in salt of phosphorus. Soluble in hydrochloric and nitric acids, more difficultly in sulphuric acid. Consists, according to Nordenskiöld, of oxide of zinc, some oxide of cadmium, and an earth in combination with a mineral acid, either boracic or phosphoric acid, and a large proportion of water. Is found in crystals in small drusy cavities with smithsonite at Altenberg near Aix la Chapelle.

HYDROMAGNOCALCITE.—In yellowish-white globular masses from Vesuvius. Analysis by v. Kobell:—carbonic acid 33·10, lime 25·22, magnesia 24·28, water 17·40. A rose-red mineral, found with emerald nickel in Lancaster county in Pennsylvania, in grains and crusts, G = 2·86, was found by Hermann to consist of carbonic acid 44·54, lime 20·10, magnesia 27·02, oxide of nickel 1·25, protoxide of iron 0·70, protoxide of manganese 0·40, alumina 0·15, water 5·84.

HYDROTALCITE.—Lamellar, flexible. On the steatite of Snarum. Analysis by Hochstetter:—carbonic acid 10·54, magnesia 36·30, alumina 12·0, red oxide of iron 6·9, water 32·66.

KAPNITE is a variety of calamine from Altenberg, in green crystals, G = 4·0...4·2, in which, according to Breithaupt, *rr′* = 72° 53′. Analyses of kapnite by Monheim:—

Carb. ox. zinc	60·35	55·89	71·08	58·52	40·43
Carb. protox. iron . .	32·21	36·46	23·98	35·41	53·24

Carb. protox. mangan. .	4·02	3·47	2·58	3·24	2·18
Carb. lime	1·90	2·27	2·54	3·67	5·09
Carb. magnesia . . .	0·41	—	—	—	—
Hydrous $\dot{\mathrm{Zn}}\bar{\mathrm{S}}$ . . .	2·49	0·41	—	0·48	—

KUPFERBLAU.—Amorphous. Fracture even...conchoidal. Lustre feeble. Translucent on the edges. Light azure-blue. Streak blueish-white. Contains silica, carbonic acid, oxide of copper and water. Is found mixed with ochre and coated with malachite in the Turjinsk copper mines in the Ural.

LANCASTERITE.—Oblique. Cleavage. *b* 010. Translucent. Lustre pearly. White. H = 2·5. G = 2·33...2·35. $\dot{\mathrm{Mg}}\ddot{\mathrm{C}} + \dot{\mathrm{Mg}}\dot{\mathrm{H}}^2$. Analysis by H. Erni:—carbonic acid 27·07, magnesia 50·01, protoxide of iron 1·01, $\dot{\mathrm{H}}$ 21·60. Is found on serpentine in Lancaster county in Pennsylvania.

LAVENDULAN. — Fracture conchoidal. Translucent. Lustre waxy, inclining to vitreous. Lavender-blue. Streak the same, paler. H = 2·5...3·0. G = 3·014. In the matrass yields water, becomes blueish-grey and friable. Before the blowpipe fusible. The melted bead crystallizes on cooling. On charcoal in the inner flame emits a strong arsenical smell. Soluble in borax and salt of phosphorus, forming a glass which is blueish-green while hot, and smalt-blue when cold. With a mixture of soda and borax on charcoal arsenical fumes are evolved, and a metallic bead obtained, consisting of arsenic, cobalt, nickel and copper. Reniform; investing other minerals. Is found in a vein at Annaberg in Saxony.

LIEBIGITE.—(L. Smith.) Green. In the matrass yields water and becomes greenish-grey, and after cooling orange. After ignition before the blowpipe remains black. With borax in the outer flame forms a yellow glass, in the inner flame a green glass. Soluble with effervescence in hydrochloric acid, forming a yellow solution. Mean of two analyses by Smith:—carbonic acid 10·2, oxide of uranium 38·0, lime 8·0, water 45·2. Is found with pechuran at Adrianople.

LÖWEITE.—A yellowish-white or yellow crystalline salt found at Ischel with karstenite. G = 2·376. Analysis by Karafiat:—sulphuric acid 52·35, magnesia 12·78, soda 18·97, red oxide of iron and alumina 0·66, water 14·45.

MANCINITE.—Fibrous. Two cleavages, one more distinct than the other, make with each other an angle of 88°. $\dot{Z}n^2\ddot{S}i$. Is found at Mancino near Leghorn.

MANGANKALK is perhaps merely a mechanical mixture of calcite and diallogite. Analyses of mangankalk *a* from Langbanshytta by Hisinger, *b* by Berthier:—

	a	*b*
Carbonic acid	44·27	41·43
Lime	42·16	35·77
Protoxide of mangan. . . .	11·77	22·80
Magnesia	1·80	—

MANGANOCALCITE.—Prismatic. Supposed to be isomorphous with aragonite. *a* 100, *m* 110. Cleavage. *a*, *m*. Translucent. Lustre vitreous. Flesh-red...dark reddish-white. Streak white. H = 4·0...5·0. G = 3·037. Infusible. Imparts the colour of manganese to the fluxes. Analysis by Rammelsberg:—carbonate of protoxide of manganese 67·48, carbonate of lime 18·81, carbonate of magnesia 9·97, carbonate of protoxide of iron 3·22. Is found in reniform masses at Schemnitz in Hungary.

MELANCHLORE is a hydrous phosphate of oxides of iron. One hundred parts contain red oxide of iron 38·9, protoxide of iron 3·9, some protoxide of manganese, and 9...10 water. Is found with triphyline at Rabenstein in Bavaria.

MISY.—Translucent. Lustre vitreous, inclining to pearly. Yellow. Before the blowpipe becomes red, and affords the reaction of iron. Analysis by Du Menil:—sulphate of red oxide of iron 42·53, sulphate of protoxide of manganese 3·42, sulphate of oxide of copper 3·11, sulphate of oxide of zinc 5·98, alumina 5·41, water 39·55. Is found massive and disseminated, in the Rammelsberg mine near Goslar in the Harz.

MOLYBDATE OF OXIDE OF LEAD (basic) from Paramo-Rico near Pamplona in South America, in small yellowish-green concretions, G = 6·0, according to the analysis of Boussingault, consists of:—molybdic acid 10·0, carbonic acid 2·9, hydrochloric acid 1·3, chromic acid 1·2, oxide of lead 73·8, red oxide of iron 1·7, alumina 2·2, quartz 3·7.

MONAZITOIDE is probably an altered monazite. Form the same as that of monazite. Brown. G = 5·281. When heated before the blowpipe glows without melting. Analysis by Hermann :—phosphoric acid 17·94, protoxide of cerium 49·35, oxide of lanthanium 21·30, lime 1·50, substance like tantalic acid 6·27, water 1·36, traces of magnesia and red oxide of iron.

MYSORINE. — Amorphous. Fracture small conchoidal. Opaque. Blackish-brown. Streak reddish-brown. H = 4·0... 4·5. G = 2·62. Analysis by Thomson :—carbonic acid 16·70, oxide of copper 60·75, protoxide of iron 19·50, silica 2·00. Was found at Mysore in the East Indies.

NITROCALCITE.—More or less translucent. White, grey. Taste bitter and sharp. Deliquesces when exposed to the air. Is decomposed by ignition. Very soluble in water. $\dot{\mathrm{Ca}}\overset{\cdots}{\bar{\mathrm{N}}}\dot{\mathrm{H}}$, nitric acid 59·35, lime 30·76, water 9·89. Analysis of nitrocalcite from Kentucky by Shepard :—nitric acid 57·44, lime 32·00, water 10·56. Is found with nitre in acicular crystals and as an efflorescence.

NITROMAGNESITE.—White. Taste bitter. Deliquesces when exposed to the air. Decomposed by ignition. Very soluble in water. $\dot{\mathrm{Mg}}\overset{\cdots}{\bar{\mathrm{N}}}, \dot{\mathrm{H}}$. Occurs as an efflorescence with nitre and nitrocalcite.

NUSSIERITE appears to be an impure variety of pyromorphite. H = 4·0...4·5. G = 5·0415. Analysis by Barruel :—phosphoric acid 19·80, arsenic acid 4·06, oxide of lead 46·50, lime 12·30, protoxide of iron 2·44, chloride of lead 7·65, silica 7·20. Is found at La Nussière near Beaujeu in France.

PEGANITE appears to be wavellite. It is found in crystals and massive, with wavellite, at Frankenberg in Saxony. $ca = 90° 0'$, $mc = 90° 0'$, $ma = 63° 30'$, $mm' = 53° 0'$. Cleavage. *a*, *c*, both indistinct. H = 3·0...4·0. G = 2·492...2·501. Analysis by Hermann :—phosphoric acid 30·49, alumina 44·49, oxides of copper, iron, &c. 2·20, water 22·82.

PICKERINGITE.—Translucent. Lustre silky. White, yellowish, reddish, greenish. Streak white. $\dot{\mathrm{R}}\dddot{\mathrm{S}} + \overset{\cdots}{\bar{\mathrm{Al}}}\dddot{\mathrm{S}}^3 + 24\dot{\mathrm{H}}$. Analyses of pickeringite *a* from Iquique in South America by Hayes, *b* in long fibres from Algoa Bay by Apjohn, *c* a similar variety from Bosjesman's river in South Africa by Stromeyer, *d* feather alum from Hurlet by Thomson, *e* feather alum from Mörsfeld in Deux Ponts by Rammelsberg, *f* hversalz from Iceland by Forchammer :—

	a	b	c	d	e	f
Sulphuric acid	36·32	36 77	35·60	32·79	36·02	35·16
Alumina	12·13	11·52	7·13	10·65	10·91	11·22
Magnesia	4·68	3·69	($\dot{\mathrm{M}}\mathrm{g}\,\dddot{\mathrm{S}}$	1·08)	0·23	2·19
Lime	0·13	—	—	potash	0·43	—
Ox. mangan.	0·43	2·17	—	7·33	$\dddot{\overline{\mathrm{F}}}\mathrm{e}$	1·23
Protox. iron		—	13·16	—	9·37	4·57
Hydroch. acid	0·60	—	—	—	—	—
Water	45·45	45·74	43·71	48·15	43·03	45·63

In long fibres and capillary crystals. The variety containing manganese is found in a cave on the Bosjesman's river in lat. 30° 30′ S. lon. 26° 40′ E. of Greenwich, Algoa Bay, Iquique in South America. Feather alum is found at Hurlet near Glasgow, Artern in Thüringia, Bodenmais in Bavaria, Mörsfeld in Zweibrücken. The hversalt is found at Krisuvig in Iceland on the surface of volcanic rocks.

PITTIZITE.—Amorphous. Fracture conchoidal. Semi-transparent...translucent on the edges. Lustre resinous. Brown of various shades. Streak light ochre-yellow. Brittle. H = 2·0...3·0. G = 2·3...2·5. Analyses of pittizite *a* from Freiberg by Stromeyer, *b* from Freiberg by Laugier, *c* from Freiberg by Kersten, *d*, *e* from the Rathhausberg by Rammelsberg:—

	a	b	c	d	e
Arsenic acid	26·06	20	30·25	24·67	28·45
Sulphuric acid	10·04	14	—	5·20	4·36
Red ox. iron	33·10	35	40·45	54·66	58·00
Oxide of mangan.	0·64	—	—	—	—
Water	29·26	30	28·50	15·47	12·59

It is found in old mines in Saxony, Bohemia and Silesia.

PLUMBOCALCITE is calcite containing a variable admixture of carbonate of oxide of lead. Analyses of plumbocalcite from Wanlockhead by Johnston, and from Leadhills by Delesse, gave:—

Carbonate of lime	92·2	97·61
Carbonate of oxide of lead	7·8	2·34
Water	—	0·05

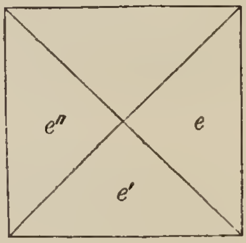
PREDAZZITE.—Analysis by J. Roth:—carbonic acid 33·98, lime 42·63, magnesia 14·05, water 7·00, alumina, red oxide of iron, &c. 0·49, silica 0·29. Is found at Predazzo in the Tyrol.

PYRRHITE.—Cubic. Simple form. *o* 111. Cleavage not observed. Lustre vitreous. Feebly translucent. Orange-yellow. H = 6. Infusible. Imparts a deep yellow colour to the blowpipe flame. In powder dissolves easily in borax and salt of phosphorus, forming a transparent yellowish-green glass. Is found in drusy cavities in felspar at Alabaschka near Mursinsk. Also, according to Teschemacher, with albite in the Azores. The crystals from the Azores, according to A. A. Hayes, consist principally of niobate of zirconia.

REUSSINE.—Analyses by Reuss:—sulphate of soda 66·04, sulphate of magnesia 31·35, chloride of calcium 2·19, sulphate of lime 0·42. Was found near Sedlitz in Bohemia.

ROMEINE.—Pyramidal. 101,001 = 55° 25′. *ee″* = 110° 50′. *ee′* = 73° 14′. No cleavage observable. Yellow H = 5·0. Before the blowpipe melts into a black slag. Slowly soluble in borax and salt of phosphorus. The glass in the inner flame is colourless, in the outer flame violet. On charcoal with soda yields globules of antimony. Insoluble in acids. $4\dot{\mathrm{C}}\mathrm{a} + 3\mathrm{Sb}\acute{\mathrm{O}}^4$. Analysis by Damour:—antimonious acid 79·31, lime 16·67, protoxide of manganese 2·60, protoxide of iron 1·20, silica 0·64. Is found in the manganese mines of St. Marcel in Piedmont.

FIG. 647.



SELENBLEISPATH.—Cleavage in one direction. Fracture uneven. Lustre resinous, inclining to vitreous. Sulphur-yellow. Streak white. Brittle. In the matrass decrepitates. At a red heat melts into black drops, and a small quantity of selenium sublimes; at a higher temperature forms a white ring of selenious acid above the assay. Before the blowpipe on charcoal melts very easily into a black slag, emits a strong smell of selenium, and the lead is reduced to a metallic state, depositing a sublimate of oxide of lead, surrounded by a sublimate of selenium. With fluxes indicates the presence of some copper and iron. Soluble in nitric acid, forming a pale green solution. According to Kersten, consists principally of selenite of oxide of lead. Is found in small globes and botryoidal masses in the Friedrichsglück mine in Glasbachgrund in the Thüringer Wald.

STROMNITE from Stromness, and EMMONITE from Massachusetts, appear to be merely mechanical mixtures of strontianite with the carbonates of barytes or lime.

STYPTICITE.—Fibrous. Translucent on the edges. Lustre silky. Yellowish-green, greenish-grey. Brittle. Single fibres slightly flexible. H = 2·5. G = 2·5. Taste sour and astringent. Analyses of stypticite *a* from Copiapo by H. Rose, *b* fibroferrite from Chile by Prideaux:—

	a	*b*
Sulphuric acid	31·73	28·9
Red oxide of iron	28·11	34·4
Lime	1·91	—
Magnesia	0·59	—
Water	36·56	36·7

Is found with coquimbite in the district of Copiapo in the province of Coquimbo in Chile.

TALKAPATIT.—G = 2·70...2·75. Soluble in nitric acid. Analysis by Hermann:—phosphoric acid 39·02, lime 37·50, magnesia 7·74, chlorine 0·91, sulphuric acid 2·10, oxide of iron 1·00, fluorine and loss 2·23, insoluble 9·50. Is found near Kusiusk in the Ural.

TECTICITE.—Prismatic. Cleavage single, imperfect. Fracture conchoidal. Transparent...translucent. Lustre vitreous... resinous. Clove-brown. Streak white. H = 1·5...2·0. G = 2·0. Taste vitriolic. Deliquescent. In small prismatic crystals and massive. Is produced by the decomposition of pyrites. Is found at Stamm Asser at Graul near Schwarzenberg, Neue Hoffnung Gottes at Bräunsdorf in the Erzgebirge.

VANADIATES OF LEAD.—Analyses of minerals consisting principally of vanadiate of oxide of lead. From an unknown locality by Damour:—vanadic acid 15·86, chlorine 2·26, oxide of lead 63·73, lead 6·62, oxide of zinc 6·35, oxide of copper 2·96, water 3·80. Supposed to be from Wicklow by R. D. Thomson:—vanadic acid 23·44, chlorine 2·45, oxide of lead 66·33, lead 7·06, oxide of iron and silica 0·16. From Mina Grande in Chile by Domeyko:—vanadic acid 15·21, arsenic acid 5·26, phosphoric acid 0·72, oxide of lead 60·56, oxide of copper 17·88, chloride of lead 0·37.

VANADIATE OF LEAD AND COPPER OXIDES from Chile. Analyses by Domeyko:—

Vanadic acid	13·5	13·33
Arsenic acid	4·6	4·68
Phosphoric acid	0·6	0·68
Oxide of lead	54·9	51·97
Oxide of copper	14·6	16·97
Chloride of lead	0·3	0·37

VITRIOLGELB.—Opaque. Ochre-yellow. H = 3·0. G = 2·729…2·880. Analyses *a* from Kolosoruk in Bohemia by Rammelsberg, *b*, *c* from Modum in Norway by Scheerer:—

	a	*b*	*c*
Sulphuric acid . . .	32·11	32·42	32·47
Red oxide of iron . .	46·74	49·37	49·89
Potash	7·88	—	—
Soda	—	5·03	5·37
Lime	0·64	—	—
Water	13·56	13·13	13·09

Is found reniform and massive in beds of brown coal at Luschitz between Bilin and Kolosoruk, Tschermig and Liebschwitz not far from Saatz in Bohemia, at Modum in Norway.

VITRIOLOCHER.—Amorphous. Fracture earthy. Opaque. Dull. Rust-brown, ochre-yellow. Streak ochre-yellow. Insoluble in water. $\overset{\cdots}{\bar{\mathrm{F}}}\mathrm{e}^{2}\overset{\cdots}{\mathrm{S}} + 6\dot{\mathrm{H}}$, sulphuric acid 16·0, red oxide of iron 62·5, water 21·5. Is found in stalactites and massive at Fahlun in Sweden.

VOLBORTHITE.—In thin fragments transparent…translucent. Lustre vitreous, pearly. Olive-green, citron-yellow. Streak yellow, inclining to green. H = 3. G = 3·55. In the matrass yields water and becomes black. Before the blowpipe on charcoal melts easily into a bright black bead, which in the inner flame becomes blackish-grey and encloses a globule of copper. With soda yields a globule of copper. With borax, or still better with salt of phosphorus, in the outer flame forms a green transparent glass, which in the inner flame becomes deep green, and remains green after the addition of tin. Soluble in nitric acid; the solution diluted after some time deposits a brick-red precipitate of vanadic acid. $\dot{\mathrm{C}}\mathrm{u}$, $\overset{\cdots}{\bar{\mathrm{V}}}$, $\dot{\mathrm{H}}$. In small hexagonal tabular crystals, sometimes aggregated in globules, fibrous, scaly, investing other minerals. Is found in the Ural in the copper mines of Turtschininow with earthy malachite, in those of Nischne-Tagilsk, in several copper mines in the government of Perm.

KALKVOLBORTHITE appears to be a variety of volborthite containing a large quantity of lime. It is found with psilomelane at Friedrichsrode. Analyses *a* of a siskin-green variety, G = 3·495, *b* greenish-grey, G = 3·860, *c* light siskin-green, by Credner:—

	a	*b*	*c*
Vanadic acid	36·58	39·02	loss 36·91
Oxide of copper	44·15	38.27	38·90

	a	*b*	*c*
Lime	12·28	16·65	17·40
Magnesia	0·50	0·92	0·87
Protoxide of mangan. . .	0·40	0·52	0·53
Water	4·62	5·05	4·62
Remainder	0·10	0·76	0·77

WISMUTHSPATH.—G = 7·67. Analysis by Rammelsberg:—oxide of bismuth 82·63, red oxide of iron 0·52, alumina 0·16, lime 0·28, magnesia 0·07, carbonic acid 6·02, water 3·16, remainder 6·98. The remainder consisted of:—silica 2·97, alumina 1·53, red oxide of iron 2·03, magnesia 0·45. Is found in the gold mines of Chesterfield county in South Carolina.

ZINKBLÜTHE.—Amorphous. Fracture earthy. Opaque. Dull. Streak shining. White, pale yellow. H = 2·5. G = 3·59. Infusible before the blowpipe. Deposits a sublimate on charcoal, which while hot is yellow, but on cooling becomes white. In the inner flame may be volatilized with the exception of a small quantity of slag containing iron. With solution of cobalt becomes green. Soluble with effervescence in hydrochloric acid. Analyses of zinkblüthe *a*, *b* from Bleiberg by Smithson, *c* from Raibel, *d* from Bleiberg, both by Karsten, *e* from Bleiberg by Berthier:—

	a	*b*	*c*	*d*	*e*
Carbonic acid	15·0	13·5	14·74	14·79	13
Oxide of zinc	72·8	71·4	72·84	72·75	67
Water	12·2	15·1	12·30	12·25	20

Is found in botryoidal, reniform and earthy masses, with calamine, at Raibel and Bleiberg in Carinthia.

Gold, p. 121.—Analyses of gold from California *a*, *b*, *c*, *d* by Rivot, *e* by Levol:—

	a	*b*	*c*	*d*	*e*
G	15·70	16·65	17·55	16·236	—
Gold	90·9	91·4	89·1	93·0	92·7
Silver	8·7	8·5	10·5	6·7	6·9
Iron	0·2	traces	0·2	traces	0·4

Analyses of gold from California *f*, *g* by T. H. Henry, *h*, *i* by Teschemacher, *k*, *l* by Oswald, *m* by A. W. Hoffmann:—

	f	*g*	*h*	*i*	*k*	*l*	*m*
G	15·96	—	16·33	—	17·40	—	—
Gold	88·75	90·12	90·33	93·00	87·6	90·96	89·61

	f	*g*	*h*	*i*	*k*	*l*	*m*
Silver	8·88	9·01	6·80	7·00	8·7	9·04	10·05
Copper . . .	0·85	0·87	—	—	—	—	—
Red ox. iron .	—	—	1·00	—	—	—	—
Sand	1·40	—	0·66	—	3·7	—	—

Iron, p. 130.—The editors are informed by Dr. Andrews, of Belfast, that he has recently made the unexpected observation, that iron is a common constituent of many igneous, and even of some metamorphic rocks, being diffused through their mass in exceedingly minute quantity, but not difficult to recognise by the employment of chemical tests in the field of a microscope. The rock broken into small fragments, without the use of a metallic hammer, is reduced to powder in a porcelain mortar, and the magnetic portions are extracted and placed under the field of the microscope. They are moistened with a solution of sulphate of oxide of copper acidulated with sulphuric acid, when metallic iron, if present, is immediately indicated by the formation of a deposit of metallic copper easily recognised by its colour, its lustre, its crystalline texture, and solubility with the disengagement of gas in weak nitric acid. The rock from which Dr. Andrews has obtained by this process the largest indications of iron in the native state, is a glassy basalt of a greenish hue, which forms the entire mass of Slieve Mish in Antrim, and occurs also at the Maiden Rocks and other localities. Even in this rock the amount of metallic iron is very small; the deposits of metallic copper from 100 grains of the pulverized rock rarely exceeding three or four in number, and varying in linear dimensions from 0·01 to 0·001 inch. It is, however, present in the entire mass of the rock. Metallic iron occurs also diffused through the other basaltic rocks of the north of Ireland, and in the indurated lias of Port Rush; also in a specimen of trachyte from Auvergne.

Petzite, p. 136.—On breaking off one of the apparently cubic crystals from the specimen of petzite, it was found to be altaite, which may also be observed intermingled with the petzite.

Tetradymite, p. 138.—Analysis of tetradymite from Virginia by Dr. C. T. Jackson:—tellurium 35·05, bismuth 58·80, sulphur 3·65, gold, red oxide of iron and silica 2·70.

Tellurwismuth, p. 139.—The editors are indebted to a private communication from Professor Rammelsberg for the following analysis by him of a small quantity of tellurwismuth from Cumberland:—bismuth 83·30, tellurium 6·65, sulphur

6·35, quartz 1·22, loss 2·48. The loss is supposed to consist of tellurium. In that case the quantity of tellurium would be 9·13.

Rutile, p. 224.—Analyses of rutile by A. Demoly:—

Titanic acid	96·41	96·45	96·43
Red oxide of iron	1·63	1·62	1·62
Oxide of manganese . . .	0·13	0·14	0·11
Silica	1·83	1·79	1·84

Periclase, p. 245.—Analyses of periclase, G = 3·674, by Damour:—

Magnesia	93·86	93·38
Protoxide of iron . . .	5·97	6·01

Magnetite, p. 259.—Analyses communicated to the editors by Dr. Andrews. In octahedrons *a* from the Mourne Mountains, *b* from Penzance, massive *c* from Greenland:—

	a	*b*	*c*
Red ox. iron	71·41	66·91	69·22
Protox. iron	21·59	31·49	29·30
Magnesia	6·45	0·09	0·71
Oxide of manganese . . .	trace	—	trace

In large octahedral crystals of magnetite in the basalt of the island of Much, off the coast of Antrim, Dr. Andrews found 2·00 per cent. of magnesia and 0·23 of oxide of manganese.

Willemite, p. 320.—Analysis of willemite from New Jersey (troostite) by H. Wurtz:—silica 27·91, oxide of zinc 59·93, protoxide of manganese 3·73, protoxide of iron 5·35, magnesia 1·66, lime 1·60.

Pseudomorphous quartz from Haytor in Devonshire (haytorite), according to the observations of W. Phillips, Phil. Mag. 1827, vol. xxix., p. 40, has the faces *a*, *c*, *t*, *g*, *m*, *d*, *o*, *n*, *e*, *h*, *u*, *k*, *x*, and the angles, of datholite. We have examined a specimen which has the form of a twin crystal, twin-face *a*, the individuals of which exhibit the combination $acge^{\backprime}x^{\backprime}\theta^{\backprime}\psi^{\backprime}\phi'$. This twin, and the form ψ 126 ($\psi a = 85° \; 20'$, $\psi b = 78° \; 9'$, $\psi c = 12° \; 46'$) do not appear to have been hitherto observed in datholite.

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